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Department of
Agriculture

Office of
International
Cooperation and
Development

Scientific
and Technical
Exchange
Division

China Program

Washington, D.C.

Biological Control of Pests in China

農業

CHINESE MEASUREMENT

a. Unit of Area

1 mu	=	0.1647 acre	=	0.0667 hectare
6.0716 mu	=	1.0 acre	=	0.4047 hectare
14.9925 mu	=	2.471 acres	=	1.0 hectare

b. Monetary Values

The Chinese currency is called Renminbi (RMB). It is denominated in yuan (Y). Each yuan is subdivided into 10 jiao or 100 fen.

On October 7, 1982, 1 U.S. dollar = 1.96 yuan.

c. Weights

1 jin	=	0.5 kg	=	1.1 pound
1 dan	=	50.0 kg	=	110.0 pounds
1 dan	=	100.0 jin		

Note: The Pinyin system of transliteration is used in this publication.

BIOLOGICAL CONTROL OF PESTS IN CHINA

FOREWORD

Joan S. Wallace, Administrator
Office of International Cooperation and Development

John R. Block, Secretary of Agriculture, has made research and extension activities one of the major priorities for the United States Department of Agriculture (USDA). The scientific and technical exchange in agriculture between the United States and the People's Republic of China are an important part of these activities.

The agricultural changes were initiated under a 1979 agreement between the United States and the People's Republic of China calling for cooperation in science and technology. The purpose of the agricultural agreement was to "promote cooperation in agricultural technology, economic information, science and education, and trade in agricultural products."

Since the signing of the agricultural agreement, over 70 teams of U.S. and Chinese agricultural scientists and administrators have visited different regions of both countries to make first-hand assessments of the status of agricultural development. The assessment of biological control of pests was one of the dominant emphases of the exchanges.

Led by Professor Huai C. Chiang of the University of Minnesota, the U.S. team investigating biological control of pests was the first sent to the People's Republic of China under the bilateral agricultural agreement. Subsequently, other U.S. entomologists visited China for more focused investigations, including the collection and identification of Chinese insect specimens. In May-July of 1982, three U.S. scientists collected and shipped over 8,000 insect specimens from China. Provisions are now being made to receive live biological control agents from the Chinese.

As part of the bilateral agreement, scientific and technical information gathered from the field visits is shared between the two nations. U.S. scientists have prepared and submitted reports on their visits to China to the Office of International Cooperation and Development (OICD). The China Program unit in OICD's Scientific and Technical Exchange Division reviews and publishes these reports.

The reports in this publication are edited from the trip reports of Jack Coulson et al. (Notes on Biological Control of Pests in China, 1979), Alton N. Sparks et al. (Notes on Biological Control of Stem Borers in Corn, Sugarcane, and Rice), and Lloyd Knutson and Robert D. Gordon (Status of Insect Taxonomy in China, with Notes on Biological Control of Pests). All comments, opinions, and recommendations in these reports are those of the authors, and not necessarily those of the sponsoring institutions or agencies in the United States or China.

This publication contains a wealth of information on biological control of pests in China and some aspects of agricultural development there. The indices of Chinese insect species prepared by Jack Coulson and his colleagues, and the directory of systematic entomologists in China compiled by Lloyd Knutson are the only comprehensive references on these subjects in the world. This work will not only enhance USDA's work in agricultural research, but also the advancement of biological science.

Many individuals have contributed to this publication: The U.S. scientists prepared the field reports, Samuel Wong, OICD, edited them, and Kitty Taylor of the Insect Identification and Beneficial Insect Introduction Institute (IIBIII), ARS, USDA, typed the entire manuscript. Both the USDA and the scientific community are grateful to them for a job well done.

Washington, D.C.
October 1982

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NOTES ON BIOLOGICAL CONTROL OF PESTS IN CHINA, 1979

by

Jack R. Coulson
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Huai C. Chiang
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William G. Yendol

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INTRODUCTION

In November 1978, a U.S. Delegation led by U.S. Secretary of Agriculture Robert Bergland visited the People's Republic of China (PRC) and negotiated a US-PRC Agricultural Exchange Accord. This accord became part of the US-PRC Agreement on Cooperation in Science and Technology signed January 31, 1979, by President Jimmy Carter and Vice President Deng Xiaoping.

During the 1978 negotiations, it was agreed that scientific exchanges would be developed between the two countries in the areas of germplasm (seed research and selection), biological control of pests, livestock and veterinary science, and agricultural education and research management methods, and groundwork was laid for cooperation in other areas.

In 1979, the International Science and Education Council (ISEC), which represented the National Association of State Universities and Land-Grant Colleges (NASULGC) and the U.S. Department of Agriculture (USDA), set up the Committee of Scientific Exchange (CSE) for working under the US-PRC Agreement. This committee formed work panels to organize and conduct long-term exchange activities.

This report is a record of the observations of a team of U.S. agricultural scientists who visited the People's Republic of China (PRC) in 1979, with the mission of learning about biological control of pests in China. The visit, coordinated by the Scientific and Technical Exchange Division of the Office of International Cooperation and Development (OICD), USDA, was part of the US-PRC Agricultural Exchange Accord. The report is based on raw observations which have not been tempered by reference to published materials or discussion with experts.

The Chinese were in the process of converting the romanization of proper and geographical names from the old Wade-Giles system to the new Pin-Yin system, which was officially adopted by the PRC Government in 1979. In this report, the new, revised romanized spellings, including elimination of hyphens in the case of given names, are used. However, many of the names of persons in the appendices may be incorrectly spelled according to the new system. Spellings of geographical place names are taken from Anonymous, 1977.

Scientific names of organisms discussed in this report and its appendices are generally cited as they were given to the delegation. All scientific names of arthropod species have been checked by taxonomists of USDA's Systematic Entomology Laboratory, Agricultural Research Service (ARS), Beltsville, Maryland, and collaborators, and the U.S. National Museum of National History, Washington, D.C., with the assistance of William L. Murphy of the Insect Identification and Beneficial Insect Introduction Institute (IIBIII). In cases where Chinese taxonomic or nomenclatorial usage differs from current American usage (differing generic combinations, synonymy, etc.), current American usage is given in brackets following that of the Chinese at first mention. Both are cross-referenced in the index, as are common names of organisms.

In addition to this report, readers might consult two other publications resulting from previous visits to the People's Republic of China -- the American Insect Control Delegation in 1975 (see AICD, 1977) and the Swedish Biological Control Delegation in 1978 (see Berner, 1979). Both publications contain helpful information on the organization of plant protection and pest control and research programs in the People's Republic of China.

BEIJING, JULY 16

On Friday, July 6, the U.S. Delegation had a briefing session with the People's Republic of China Ministry of Agriculture and visited the Institute of Zoology of the Chinese Academy of Sciences in Beijing. The following are the notes from the briefing and the visit.

General Briefing by PRC Ministry of Agriculture

According to the Ministry of Agriculture, the earliest record of biological control in China was in 324 B.C., with the use of *Oecophylla* ants in citrus. Many significant developments in biological control and other aspects of plant protection have occurred since liberation in 1949, including use of *Aphelinus mali* in north China, biological control of the pink bollworm with *Dibrachys cavus* in central China, and development of use patterns of synthetic organic chemicals in the 1950's. (This had, in some instances, had adverse side effects.)

Prevention was the key strategy in plant protection in the People's Republic of China, and this was supplemented by integrated control, of which biological control was a major component. In the People's Republic of China, plant protection policy also involved the following points: (1) Use of quarantine to limit and retard the spread of plant pests, (2) measures to protect or conserve beneficial organisms, (3) education and communication programs to advance integrated control, (4) development of pest resistant crop varieties, (5) judicious use of water and fertilizer to help lower pest infestations, (6) almost universal use of sanitation practices, (7) augmentation of biological control agents, (8) reasonable use of synthetic organic chemicals, and (9) heavy reliance on pest survey and monitoring programs as a basis for control decisionmaking.

In 1972, 1,200,000 mu were under biological control in the People's Republic of China; in 1978, there were 130,000,000 mu under biological control, a tenfold increase in 7 years (1 mu = 0.1647 acre).

The mounting of large-scale, unified, organized programs was difficult. There was a great variety of programs which required "unification" throughout the People's Republic of China, and these programs had to be designed to benefit the people. The Ministry of Agriculture was currently attempting to unify programs in plant protection. One basic measure being undertaken was the taxonomic classification and re-evaluation of natural enemies of crop pests in the People's Republic of China. Two training courses for research and technical teams were in progress in northern and southern China for this purpose.

One example of good organization was the program for control of locusts, which were once major pests in China. In 1949-1950, 40 to 50 million mu were affected. Millions of people were organized to modify locust habitats throughout China to make them less suitable for locust development. Based on this principal, every province, since 1971, had utilized local methods to control locusts. (See also AICD, 1977: 144-145, for more details.)

The following were four characteristics of biological control in the People's Republic of China:

1. Pass technology of biological control directly on to the people who will use it.

2. Combine "three into one" (research, technology, and administration or extension). Examples given of the effective use of this policy were the use of Trichogramma for corn borer control, and control of the apple leafroller in Jilin Province. (Trichogramma was said to have been used on 200,000 mu of corn in Jilin Province in 1978.)

3. Take natural enemies as the main measure of plant protection. This measure, that is, protection and application of natural enemies, had proven to be "economical and convenient" for use on communes. It was easy for people on the communes to learn this technology. Examples cited of natural enemies proven to be of practical use were Rodolia beetles, Chrysopa, and spiders.

4. Develop microbiological measures of control. There was a major thrust underway in developing the use of microbial preparations for suppressing insects and plant pathogens. In 1979, major emphasis was on fermentation production of Bacillus thuringiensis (B.t.) for control of insects, and on streptomycin preparations for control of fungal diseases of rice. This thrust, however, was handicapped by the fact that the fermentation plants were mostly "small and not modern," and overall production of microbial preparations was at a low level. Some fermentation plants were located on communes, which used rice bran, stover, and similar materials, for fermentation. (B.t. was produced in small factories for local use, and byproducts were used in other ways; thus, costs were reduced.)

More basic research (versus applied research) was needed. The number of natural enemy species used in augmentation programs as of 1979 was small, but was expected to increase. And the number of introduced natural enemies had been small, but many more would be introduced in the future. A new biological control laboratory had been created to help in the coordination of natural enemy studies, primarily concerning the introduction or exchange of natural enemies.

Institute of Zoology, Chinese Academy of Sciences (CAS)

The Institute of Zoology had 600 staff members, 180 of which were professors or associate professors. The institute was divided into ten divisions (or departments), five of which related to pest control, including entomology. Entomological research areas at the institute included the following: (1) Population dynamics of cotton bollworm (Heliothis); (2) insect nutrition, metabolism and physiology, including hormonal control of insect growth and development; (3) use of natural enemies in managing insect pests of agriculture and forests; (4) insect pathology, including nuclear polyhedrosis and granulosis viruses and Bacillus thuringiensis; (5) insect sex pheromones (specifically of the pine caterpillar, Dendrolimus); (6) visual responses of noctuids and their physiological bases; (7) effects of chemicals on insects (chemical structure--biological activity of insecticides); (8) insect resistance to insecticides (structural, physiological and biochemical mechanisms of insecticide resistance, as well as the genetics of insecticide resistance); (9) insect taxonomy; and (10) bionomics and distribution of parasites and predators.

Insect resistance to organophosphates and organochlorines was studied at the Laboratory of Insecticides and Toxicology. The laboratory had been selecting a DDT-resistant house fly (Musca domestica) colony since the 1950's. The flies were placed in large Erlenmeyer flasks which had been coated internally with a certain 5 percent organic solvent solution of DDT. Virtually all of the flies were completely resistant to the DDT. The main mechanism of resistance was reduced penetration. The major metabolite was DDE, indicating the presence of DDT-dehydrochlorinase. The inheritance of these mechanisms had been ascertained. Biochemical (electrophoretic) studies on BHC resistance and studies of DDVP resistance were in progress. The laboratory was also studying resistance to Systox in aphids. It was not attempting to devise strategies to retard the rate of development of insecticide resistance.

The Division of Insect Physiology was concerned with studies in the following areas.

1. Identification of the brain hormone of the silkworm, Bombyx mori. This work was in collaboration with the Department of Agricultural Chemistry, University of Tokyo, Japan. The hormone was a protein with a molecular weight of ca. 400,000 daltons.

2. Predator rearing and nutrition. Adults of Coccinella septempunctata and Leis [=Harmonia] axyridis were being reared on a 5:1 mixture of pork liver powder and sucrose (cane sugar). [The diet had been published (DIB and SBC, 1977; see also Wang et al., 1977, for related information regarding coccinellid reproduction).] This resulted in a preoviposition period of 3 weeks versus the normal 5 to 6 days. However, a considerable number of viable eggs were laid by adults fed in this manner. If the nutrition of the adults was inadequate, they entered a reproductive diapause. This diapause could be broken with juvenile hormone analogs. Larvae could not be reared on this diet.

Coccinella septempunctata populations developed rapidly on aphid populations on winter wheat. Large teams of people collected these insects from the wheat fields and released them on cotton seedlings. A release ratio of one C. septempunctata per 200 aphids on cotton was said to assure control. Larvae of the arboreal coccinellid species Leis axyridis were collected from the branches of trees in Hunan Province and then released on agronomic and horticultural crops. When these individuals reached the adult stage, they left plants with a low growth habit and transferred to trees. Nevertheless, the larvae were said to be highly effective in suppressing aphids.

3. In vitro rearing of Trichogramma. Trichogramma had been reared from egg to egg on an artificial medium. This was accomplished by encapsulating hemolymph in paraffin, that is, "a hanging drop of nutrient medium." The females oviposited in this "paraffin ball." (See Guan et al., 1978, for details.)

4. Physiological control of egg production in coccinellids. Coccinellids exhibited "reflex bleeding." Hemolymph collected in this way was analyzed electrophoretically for vitellogenin. Three days after the appearance of vitellogenin in the hemolymph, eggs were deposited.

The Insect Pathology Section was working on the isolation of new pathogenic strains and on mechanisms of pathogenicity in 1979. Current emphasis was on selection of strains of Bacillus thuringiensis. The section

had isolated six serotypes from the People's Republic of China, including serotypes 1, 3, 5a and 5b. Serotype 5 was very widely distributed in the People's Republic of China. In all, the section had studied 14 serotypes. Serotypes 1, 3, 5a and 5b had been reintroduced into the field for control. The section had obtained serotypes from France and the United States. Communes obtained their serotypes locally and produced them using stover, rice hulls, and other materials, for fermentation. Viruses had been isolated from Pieris [=Artogeia] rapae, Agrotis segetum, Heliothis armigera, and other insects (see Tsai et al., 1978; and Hwang and Tsuey, 1975). The Heliothis NPV was being produced on communes in Hunan Province. (Samples of the granulosis virus of P. rapae and an NPV of Prodenia [=Spodoptera] litura were presented to the delegation. See Appendix 2 for list of and notes on live biological control material obtained by the delegation from People's Republic of China scientists.)

The Insect Vision Section had studied the phototactic behavior of noctuids. The noctuids studied were Heliothis (bollworms) and Leucania (armyworms). A visual choice chamber about 120x120x25 cm was used for the study. Noctuid adults were introduced into a chamber at the bottom, and prevented from flying upward until desired by two movable baffles which, when closed, formed an inverted V. Up to four bands of monochromatic light in various mixtures and intensities could be shone downwards from two lens arrangements at the top of the apparatus. These lens arrangements were about 60 to 70 cm apart. Under each lens arrangement there was a ca. 20x20 cm cage with a ca. 5-cm diameter hole through which the light was focused on the baffles. After the insects had become adapted to the space enclosed by the movable baffles, they were released and were free to choose to enter one of the cages through which the light shined. Thus, behavioral responses to various light waves and mixtures of light waves could be studied in a situation permitting choice. Studies to date indicated that noctuids responded most strongly to 405 nm. Responses were apparently strongest to single wave lengths rather than to combinations of wave lengths. The section also used a sophisticated instrument for measuring relative amounts of light of various wave lengths shone on compound eyes, as well as of reflected light. Responses were measured with an oscilloscope. The purpose of this work was the improvement of light traps for monitoring field populations. (Pertinent papers for more details are: Ting et al., 1974; Li and Ma, 1977; Ting, 1978; and Hou and Ho, 1979.)

The Insect Pheromones Section had identified some components of the Dendrolimus pine caterpillar pheromone. Three active peaks were obtained on the GLC. (Activity was measured by the electroantennogram technique.) Two of these peaks were (Z, E)-5, 7-C_{12} OH and (Z, E)-5, 7-C_{12}. Single components attract males to traps but the above two in combination were particularly potent. (See SIP, 1973, for more details of this work.) The Section had a Swiss-made Perkin Elmer GLC and had access to a mass spectrometer.

The insect collection of the institute's Department of Taxonomy and Faunology was the largest in China, containing about 2,000,000 specimens. It was a well-maintained collection. There was a staff of 60 (not all taxonomists). The department halls contained a number of exhibits, including Trogoderma persicum [=T. variabile] and other Dermestidae taken from ancient tombs. Also, specimens of Heliothis assulta and H. armigera were of particular interest. There were exquisite displays of the life cycles of the most important insects attacking China's major crops as well as a display of medicinal and dietary uses of insects.

BEIJING, JULY 7

On Saturday, July 7, the delegation visited the Beijing Academy of Agricultural Sciences and the Chinese Academy of Agricultural Sciences. The following notes include observations on the Trichogramma Laboratory, the Biological Control Laboratory, the Laboratory for Radiation Sterilization for Control of Corn Borer, and the Agricultural Antibiotics Laboratory of the two Academies, and the Beijing Agricultural University.

Beijing Academy of Agricultural Sciences (BAAS)

The Beijing Academy of Agricultural Sciences had four divisions: Soils and Fertilizer, Animal Health, Horticulture, and Pest Control. The pest control studies of the academy (which was part of the municipal rather than the national academy organization) included the following experimental work: (1) *Trichogramma* for control of *Ostrinia* in corn; (2) *Chrysopa* (*sinica*) for control of *Heliothis* in corn, cotton, and vegetables (cucumbers and tomatoes) in the field; (3) predatory mites (*Phytoseiulus persimilis*) for control of spider mites (*Tetranychus urticae*); and (4) *Encarsia* and *Chrysopa* for whiteflies in greenhouses. The academy was attempting to integrate crop protection methods with crop production methods used by commune workers.

Trichogramma dendrolimi (on a large scale) and *T. evanescens* (on a small scale) had been used for control of *Ostrinia* (corn borer). In 1977, a new species, *T. ostriniae*, found in the local area, was found to be better than *T. dendrolimi*. It was then being used, and was expected to be used more widely in the future. This was the only species under culture during the delegation's visit. Identifications of *Trichogramma* were made by specialists of the Zoological Institute in Beijing.

Eggs of *Corcyra cephalonica* (rice moth, a storage pest) were used for *Trichogramma* production. *Corcyra* was preferred over *Sitotroga* because the former was more economical to rear. (The eggs of the oak silkworm, used elsewhere as a laboratory host for *Trichogramma*, could not be used, since *T. ostriniae* could not successfully parasitize them.) A diet, consisting of 90 percent pasteurized wheat bran, 5 percent soybean flour, and 5 percent wheat flour, to which was added 15 percent moisture (by weight), was used for rearing *Corcyra*. The diet was sterilized at 65° C for 25 hours. One-half kg of diet produced 800 *Corcyra* adults (both sexes), which produced 60,000 eggs which produced enough *Trichogramma* (one per host egg) for releases on two mu. About 60 percent parasitization was achieved in the laboratory. *Trichogramma* production at the laboratory was only for experimental use for ca. 1000 mu. The communes produced the *Trichogramma* for practical control.

After host egg harvest, the eggs were exposed to parasites in a glass-topped wooden box (about 50x50x30 cm). The eggs were placed on plastic trays one above the other. At the bottom of the box, petri dishes containing previously parasitized eggs were placed to provide parasites for oviposition. A U-shaped piece of black cloth was placed over the glass top and a translucent piece of white paper covered the glass inside of the U. By using this arrangement to shift light intensity in the box, the *Trichogramma* were herded across the eggs by their phototactic response to light.

Each 300 plastic trays were capable of yielding 3 million *Trichogramma* per day. In the rearing process, there was a tenfold increase of *Trichogramma* each 4 days. The egg trays were changed four times during the 4-day period which was approximately the life span of the adult *Trichogramma*. In normal production, parasitized eggs were held 4 to 5 days at 25° C, at which time they became grayish in color. They could then be placed in a refrigerator at 5°-7° C for storage for up to 2 weeks.

A total of 15,000 to 20,000 parasitized eggs were distributed per mu. Until then, five distribution points per mu had been used. By 1979, research had shown that by placing the parasitized eggs at the proper height in the corn plants, only one distribution point per mu was needed. Since *Ostrinia* had two generations per year at Beijing, two or three releases of *Trichogramma* were made. The parasitized eggs were placed loose in small plastic containers for distribution in the field. These were suspended from the corn plants. Previously, match boxes had been used for field distribution.

The academy also conducted greenhouse experiments on determining guidelines for practical use of *Phytoseiulus persimilis* (recently introduced from England) against *Tetranychus urticae* on beans, and similar experiments on the use of *Encarsia* against *Trialeurodes* whiteflies. The latter parasite was used on the communes to protect tomatoes, French beans, and tobacco.

Chinese Academy of Agricultural Sciences (CAAS)

The Chinese Academy of Agricultural Sciences was founded in 1957. It consisted of 31 research institutes responsible for agricultural research for most of China.

The Biological Control Laboratory of the academy was known previously as the *Chrysopa* Laboratory. In 1979, the main research effort was focused on developing the use of *Chrysopa* to suppress *Heliothis* on cotton. The focus was on methods of *Chrysopa* production handling and distribution. The technology developed had to be reasonably simple so that it could be readily adopted by communes.

Of the seven or eight species of *Chrysopa* present in China, four were being reared at this Laboratory:

Species	% Harvest survival
C. septempunctata (predaceous in both adult and larval stages)	70%
C. sinica (predaceous only in larval stage, as are the the remaining species studied)	60%
C. formosa	80%
C. carnea (present only in Xinjiang Province)	(small culture only)

(Pinned specimens labeled *C. "shaniensis"* and *C. boninensis* were also noted by the delegation.)

The methods of rearing were unsophisticated but effective. They were geared to the capabilities of workers on communes who were not professional entomologists. Technology developed in Texas and California was felt to be

too sophisticated at that time. Strips of clear polyethylene, 0.5 cm wide, were placed in wooden boxes, each 55x35x10 cm. These served to keep the immatures separated, thereby minimizing cannibalism. For C. sinica, about 60 percent of the eggs reached the pupal stage. This rate was 70 to 80 percent for the other species.

The larvae were fed on the eggs of the rice moth, Corcyra cephalonica, as were the predaceous adults. This was accomplished by coating 7x12 cm cards with 50 percent honey to which a monolayer of eggs was attached. The cards were placed in the boxes and the predator fed on both the eggs and the honey. Alternatively, host eggs were provided in a sawdust mixture. Generally, with 2000 Corcyra eggs, 1000 to 2000 Chrysopa cocoons could be produced. The top of the wooden rearing box was covered with a fine brass screen. A 15x15 cm glass plate, held in place in the center of this lid, served as a door through which four or five cards with eggs were introduced. The adult diet consisted of a mixture of yeast, honey, sugar and water. (Autolyzed yeast was made at the laboratory; it was not available commercially in China.) On this diet a female produced an average of 100 to 800 eggs in 45 days.

Chrysopa sinica was the species most used in control programs. It was best in cotton since it preferred Heliothis eggs. Other species were more polyphagous. Three releases per season were made in cotton, totalling 20,000 larvae per mu, or four to six per cotton plant. If the aphid population on cotton was high, control of Heliothis was poor because of "prey dilution." If ant populations in cotton were high, results were also poor, as ants could eat up to 50 percent of the released Chrysopa within 24 hours. Aphids and Heliothis were the major problems in cotton; Coccinella septempunctata was often used against the aphids. One additional problem was that Heliothis populations were erratic, and reliable and precise evaluation data could not therefore be obtained readily in two or three seasons.

Chrysopa septempunctata was the best species for use on fruit trees and in the greenhouse; it preferred aphids. Its larvae were also reared on Corcyra eggs. As discussed above, its adults were also fed Corcyra eggs, though a diet of autolyzed yeast plus honey and sugar, as noted above for the adults of C. sinica, might be used as a supplement.

About 600 to 800 eggs per female were obtained in 45 days (a maximum of 2000 eggs could be obtained from one female). Adults were held in small circular cages and eggs were obtained from removable plastic strips around the sides, or from container tops. These were cut (swept) for hatching and placement for larval rearing.

The host, Corcyra, was reared at 28° C, 70 percent RH, no light, on a diet of 90 percent wheat bran and 10 percent corn flour (or 5 percent corn flour and 5 percent soybean flour). One kg (total weight) of diet was used for 3000 host eggs. Moth emergence began in 45 days and continued for 1.5 months. There were some fungus and disease problems. Collecting the adults was very time consuming. They were neither strongly geotactic nor phototactic. Therefore, a lid of two layers of hardware cloth, 3 to 4 cm apart and open at the ends, was placed on the boxes. The moths climbed from the diet into the space between the hardware cloth. The lid was then held vertically above a polyethylene funnel and shaken. The moths fell into a one-liter metal cannister at the bottom of the polyethylene funnel. The bottom of the cannister had a cloth sleeve from which the excess bran was removed. A large funnel for removing moths from seven lids at one time was available for use.

The laboratory had an apparatus (which its staff jokingly called an "18th Century Machine") built by one of the investigators for making artificial eggs (for chrysopid rearing) by using paraffin (melting point of about 55° C) to encapsulate hydrolyzed protein. The diet was not yet satisfactory. Casein was not available in the People's Republic of China, and soybean juice was used instead.

Some work was underway by the laboratory on the use of Coccinella septempunctata against aphids on cotton. Without such use, five insecticide sprays per season were needed. There were difficulties in rearing, since brewer's yeast was not available in the countryside. Instead, ordinary baker's yeast was used. The latter was low in vitamins, but the adults produced a few eggs when it was used in diets.

Institute for Application of Atomic Energy in Agriculture, CAAS

The Institute for Application of Atomic Energy in Agriculture, located at Beijing Agricultural University, was founded in 1957 and in 1979 had a staff of 230, of which just over half were research workers. There were three basic research missions: (1) A study of mutation breeding by use of gamma radiation (a number of important successes had been scored in inducing useful traits in a variety of crops, including early maturity, and so forth); (2) use of radioactive isotopes to study the metabolism, movement and fate of various agricultural chemicals; and (3) control of insects by sterilization methods. They also studied instrumentation for measuring plant responses and for studying the processes of plant growth, development and phenology, nitrogen fixation and radiation preservation of food (and also use of radiation to protect raw commodities). The institute had two electron microscopes (partially used for study of viruses), a French-made neutron accelerator (for plant mutation studies), and a Cobalt-60 irradiator (for sterilization purposes), installed in 1958. The institute conducted training of personnel throughout China in the use of radiation and radioisotopes. A nuclear reactor was being planned just for agricultural uses at the institute.

The Laboratory for Radiation Sterilization for Control of Corn Borer began its work in the early 1960's. They had found that substerile doses were better than fully sterilizing dosages. The greater dosages affected the mating ability of the Ostrinia moths. A gamma ray dose that induced complete sexual sterility in males was found to be debilitating. Therefore, the dose was reduced to the level that fully sterilized females. This dose nevertheless resulted in a high level of sterility in males. Field cage tests were then in progress in which both sexes were released.

The laboratory also found that if a normal (N) female mated first with a sterile (S) male, and then with a N male, most eggs were fertile; but if an N female mated first with an N male and then with a S male, most eggs would be infertile. That is, the first sperm in the spermatheca were "pushed aside" by the second batch of sperm.

The morphology of the male reproductive tract was somewhat different than that of species previously used in such studies. The bursa copulatrix was quite distant from the opening of the seminal duct. Thus, the spermatophore from the last mating displaced the spermatophore of previous matings. The following data were obtained when normal females were mated:

	Eggs produced	Percent Hatch
Normal female x Sterile male	881	0
Normal female x Normal male	2479	93.8
Normal female x Sterile male followed by Normal male	1696	97.0
Normal female x Normal male followed by Sterile male	860	8.1

Studies on normal and sterile moths involving the transfer of eupyrene sperm, mating behavior in the field, and so forth, had not yet been done. However, ratio tests in jars and field cages indicated that the sterile males were performing well under these circumstances.

The results of the cage studies, utilizing various ratios of N to S, looked promising. Wild populations had been used to check mating competitiveness. The laboratory wished to test this technique on an island (yet to be determined) off the coast of Liaoning Province.

A diet for mass-rearing *Ostrinia* had been developed, adapted from diets in U.S. literature. A first diet, based on a publication by S. D. Beck (University of Wisconsin), was put into use in 1965, and consisted of 15 g soybean meal, 7.5 g glucose with six vitamins ("sold commercially"), 9 g brewer's yeast, 0.5 g sorbic acid, 2 g agar, with 100 cc water. In 1973, this diet was revised based on a publication by W. D. Guthrie (USDA, Ankeny, Iowa). This diet, in use in 1979 as "diet No. 7," consisted of the following ingredients:

Soybean meal (autoclaved--6-7 kg--for 30 minutes)	- 15.0 g
Multivitamin glucose	- 7.5 g
Brewer's yeast (110° C, 1 hour)	- 9.0 g
Sorbic acid	- 0.5 g
Agar	- 2.0 g
Water	- 100 cc

The laboratory had healthy borers cultured on this diet, and also adult egg production.

The corn borer was a most difficult choice for this research. It was chosen because of the availability of a diet for its ready culture and its importance to Chinese agriculture. (Corn borer activity in north China was stated to occur during June-August.)

Chinese taxonomists did not agree with the conclusions of Mutuura and Munroe (1970) that the species in China was *Ostrinia furnacalis*. Instead, they believed it to be *O. nubilalis*. (But see notes taken at the Shanghai Institute of Entomology, July 21, and results of specimen identifications in Appendix 5). Cooperative US-PRC studies and pheromones of *Ostrinia* species have been completed and the results have now been published (Klun et al., 1980). The components of the *Ostrinia nubilalis* pheromone were not attractive to the corn borer in China. The Changchun Institute of Applied Chemistry had isolated and identified two components which were attractive to the Chinese corn borer (see notes taken for July 13).

Agricultural Antibiotics Laboratory, CAAS

The Agricultural Antibiotics Laboratory had experiments with introduced antagonists to control soilborne pathogens of cotton and wheat. In the 1950's, both *Verticillium* wilt of cotton and wheat "rust" were less severe in the respective crops following 3 years of alfalfa planting. Two thousand strains of actinomycetes were isolated from the roots of alfalfa and another 2000 from cotton soil. Each isolate was tested in a petri dish on solid media for antibiotic production against two test fungi, *Verticillium albo-atrum* and *Rhizoctonia solani*. The average zone of inhibition was five times greater for the 2000 isolates from alfalfa than for isolates from other sources. From this collection, isolate 5406 was selected as the best, having a broad spectrum of activity against fungi and bacteria. This strain was then grown on a medium of 50 percent soil and 50 percent bean meal, bran, and the agar medium which presumably was part of the inoculum or spawn used to start large cultures. This medium was allowed to incubate in large pans with 5406 for an unspecified time. The mixture was then dried, powdered, and packaged for shipment to communes. Communes apparently produced their own inoculum (see notes for July 18). More than 100,000,000 mu of cotton had been treated as seed and/or soil during the past 30 years, with resultant improvements in stands and plant vigor. The treatment gave the best response in soil at 8° C compared with 12° or 15° C (which indicated that it would work against *Pythium*). It was also claimed that the antagonist worked to control rust. However, no data were presented. In their purification studies, the Laboratory had evidence that two antibiotics were produced by 5406, as well as auxin.

In another study, the laboratory had screened several hundred strains of actinomycetes. From these, strain 2316 was found to produce a broad spectrum antibiotic. The strain came originally from soil from Guangxi Province. This strain was grown in fermentation culture, from which the antibiotic was recovered. A concentration of 0.1 ppm (in agar in a dish) controlled *Phytophthora palmivora*. The antibiotic was being painted on rubber trees in southern China (Hainan Island) as the bark was stripped away to harvest the latex. The antibiotic gave better control of *P. palmivora* than did a Swedish product, "Antimycin" (mainly mercury).

Notes on Beijing Agricultural University

The Institute for Application of Atomic Energy in Agriculture and the Agricultural Antibiotics Laboratory were located in a complex that included the Beijing Agricultural University. This was the official name of the university from 1949 to 1969. From 1969 to 1972, the university was moved to Yan'an, Shaanxi Province, and renamed the North China Agricultural University. This was relocated between 1972 and 1974 to Hobei Province, 60 km from Beijing. In 1974, the university was reestablished in Beijing, but was not renamed Beijing Agricultural University until 1979. The university's Department of Plant Protection had a total staff of 50 to 90 (about 30 teachers in 1979), and was divided into an entomology group, a plant pathology group, and a microbiology group, plus a biological control laboratory.

BEIJING MUNICIPALITY, JULY 8

On Sunday, July 8, the delegation visited the Miyun County Biological Control Experiment Station. The following are notes on that visit.

Miyun County Biological Control Experiment Station

The experiment station, located northeast of Beijing on a fertile plain with mountains in the distant background, was under the county plant protection and quarantine administration. Wheat and corn were the main crops in the county, but there were a number of other miscellaneous crops, including fruit. Agricultural production in the county was primarily for Beijing City. The county also had a large reservoir to serve Beijing City. There was, therefore, a strong need to control pollution from runoff of agricultural chemicals.

The station was built in 1977. It produced Trichogramma for use against (1) the corn borer (Ostrinia) on corn, (2) the "fruit borer" (Grapholitha [=Grapholita] molesta) and leafrollers in fruit, and (3) pine caterpillars (Dendrolimus) in forests. Nine to 10 billion Trichogramma were produced at the station per year, which was enough for 80 percent of the biological control effort in the county, including treatment of about 150,000 mu of corn, 270,000 mu of pine forest, and about one half (50,000 mu) of the county's fruit (apple, apricot, pear, peach) production.

The main species used at the station was Trichogramma dendrolimi, reared on eggs of the giant oak silkworm, Antheraea pernyi. A small amount of T. ostriniae was also cultured, on Corcyra cephalonica. Though T. dendrolimi was said to be "better than T. ostriniae," the latter was to be used more extensively in the future since it was easier to rear. Trichogramma dendrolimi could not be established on corn borer in the field. Trichogramma ostriniae could not be reared on oak silkworm eggs.

Trichogramma dendrolimi was reared on oak silkworm eggs. Although up to 80 Trichogramma per egg were produced, the average number was about 50 per host egg. Female oak silkworm cocoons were collected from the mountains in northeastern China, where the larval stage was reared on leaves of oak trees (see notes for July 12). The cocoons were transported to the Miyun Station and taken to a building with large windows and no doors. Dimensions of this building were ca. 36x10 m. Within this building the cocoons were spread out as a monolayer on three tiers, 6x30 m each. Thus, 540 m^2 of holding surface accommodated in excess of 600,000 cocoons at one time. Since each female moth produced 200 eggs and each egg yielded about 50 parasites, the number of parasites produced from one female should be 10,000. The cocoons were a side product of the Trichogramma production, and were provided to the silk industry after emergence of the moths. (Emergence apparently did not destroy the cocoon's value for silk production. But see notes for July 10; perhaps male cocoons only were used for silk production.)

The emerging female moths rested on strips of cloth suspended from rails along the sides of the emergence platforms. The gravid female moths were removed by hand and placed in an electrically driven grinder to extract the eggs. A stream of water carried the eggs and other body fragments from the grinder into an oblong settling basin. The eggs settled to the bottom and lighter debris was decanted over the edge of the basin. A partition at

the edge of the settling basin was then opened, and the eggs were washed into another basin with a funnel for collecting the eggs. The eggs were then spun dry for ten minutes in a centrifuge.

Eggs could be extracted from 1000 female moths per hour with a single machine. During the busy season (June), up to 1 ton of moths could be processed per day -- or 120 kg of moths per hour. Approximately 21 kg of eggs were obtained per hour (about 10,000 eggs = 1 kg). About 10 minutes were required to dry 50 kg of eggs. The egg of the oak silkworm had an extremely tough chorion, so no damage occurred during these processes.

For parasitization, the eggs were placed as a monolayer on trays in a box, ca. 1x1.5x0.5 m, with a glass top. By manipulating the light with a black cloth the *Trichogramma* were moved onto the tray. This process required about 6 minutes. The tray was then transferred to a darkened holding chamber for 36 hours. After this, the eggs were placed on a sieve to separate out the *Trichogramma* adults. The eggs were then stored in a cellar cold-room at 6° C. They could be stock-piled in this manner for up to 6 months. When needed, the parasitized eggs were mixed in a ratio of 1:20 with unparasitized eggs and shipped to the communes. (Since only about 70 percent of the exposed eggs were parasitized, unparasitized eggs could be removed for host colony maintenance purposes by placing the eggs in water; the parasitized eggs floated to the surface.) At the communes, the parasitized and unparasitized eggs were placed in plastic capsules, 5 cm in diameter and 1 cm in depth, with four side ports to allow the escape of the emerging adult parasites. Parasites emerged from the parasitized eggs and parasitized about 90 percent of the other eggs in the capsules.

Six-hundred oak silkworm eggs were placed in each capsule and one capsule was generally placed per mu. (Thus, with 95 percent unparasitized eggs being parasitized in the capsule at the rate of 90 percent, and each parasitized egg yielding an average of 50 parasites, about 25,650 parasites were applied per mu.) The capsules with eggs were deployed on the basis that the effective radius of dispersal of *Trichogramma* was believed to be about 20 m. Thus, where large trees in an orchard were to be protected, one capsule of eggs was placed for every two trees.

Using this release rate, 80 to 90 percent of corn borer eggs were parasitized in corn by *T. dendrolimi*, whereas *T. ostriniae* naturally parasitized only about 5 percent. Without *Trichogramma* releases, 80 percent of the corn plants would be infested by one or more corn borer larvae per plant; with *Trichogramma* releases, only 8.5 percent of the plants were infested, for 84 percent control of the rate of plant infestation. A natural five larvae per plant would occur with an average of 10 percent yield loss per larva, and as high as 40 percent if the plant was attacked at the milk stage.

Trichogramma dendrolimi did not become established on the corn borer and had to be released annually, nor did it "cycle" on the borer. Thus, although *T. dendrolimi* could give completely adequate protection of corn (at harvest 8.5 percent of corn plants had borers in fields protected with *T. dendrolimi* versus about 50 percent in the absence of releases), greater releases of *T. dendrolimi* were needed than of *T. ostriniae*, which was a normal field parasite of *Ostrinia*.

Production of T. ostriniae had been initiated on Corcyra cephalonica using essentially the same methods already described for the Trichogramma Laboratory, Beijing Academy of Agricultural Sciences (see notes for July 7).

There were three generations of corn borer per year within the Beijing area, with the first one occurring in late June.

BEIJING, JULY 10

On Tuesday, July 10, the delegation made a second visit to the Institute of Zoology of the Chinese Academy of Sciences. It also visited the academy's Institute of Microbiology. The following are the notes on these visits.

Institute of Zoology, CAS; Second Visit

In the second visit to the Institute of Zoology, a rough estimate of some of the holdings in parasitic groups of the institute's insect collection was made. The specimens were contained in cardboard boxes (about 20x25 cm), approximately eight boxes for each of four compartments of the cases. The following number of boxes were estimated: Ichneumonidae, about 90-100; Braconidae, about 60-64; Alysiidae and Trigonalidae, about 30; Chalcidoidea, about 110-120; Torymidae and Agaonidae, about 18; Tachinidae, about 1100; Coccinellidae, about 125. In the coccinellid collection, there were specimens of Cryptolaemus montrouzieri collected in Guangzhou (Canton) in 1956 and of Rodolia cardinalis collected in Zhejiang Province in 1959. This indicated that these two exotic species, introduced into the People's Republic of China in the 1950's, were recovered (see also notes for July 28). There were also six species of Stethorus in the collection (of the 12 species known in China). In all, there were about 80 identified species of predaceous coccinellids and six boxes of identified epilachnine species in the collection. There were also large collections of Formicidae and Apoidea. (There were no labeled specimens of Osmia cornifrons among the Osmia species.)

The Laboratory of Insect Hormones conducted research on insect sex attractants. The emphasis on sex attractants involved the following species: (1) Dendrolimus punctatus, pine caterpillar (the identification of this pheromone had just been accomplished but information had not been published -- the synthetic pheromone was quite potent in the field); (2) Gynaephora "ginghainensis," the grassland moth (the wingless female produced a 21-carbon alkene); (3) Euproctis pseudoconspersa, the tea tussock moth (the Laboratory had made biologically active extracts, but structure was unknown); (4) Carposina niponensis, the peach fruit moth (the structure of the pheromone was published in about 1975 in the Journal of Agricultural Sciences -- it consisted of cis- and trans-isomers of two ketones); and (5) Polychrosis [=Lobesia] cunninghamiacola, an olethreutid moth which attacks a tree (which evidently has no English common name).

The scope of the laboratory's sex attractant work appeared to be limited to insect pests of forests, tree fruits (excluding citrus and subtropical fruit) and grasses. (Work on subtropical pests and on cotton was conducted in Shanghai. Evidently work by the Shanghai group on confusion of pink bollworm had led to discouragement in using the air permeation technique of preventing mating.)

Some of the major problems confronting pheromone research in the People's Republic of China included the following: (1) Very limited capability in the People's Republic of China for formulating pheromones; (2) inadequate R&D on industrial scale synthesis; and (3) limited experience in conducting field studies on air permeation, and so forth.

Institute of Microbiology, CAS

The Institute of Microbiology was working on tobacco mosaic virus (TMV), barley stripe mosaic, cauliflower mosaic, rape mosaic, and other viruses. The institute displayed the use of fluorescent antibody and ELISA; its staff could detect 10 ng of TMV per ml of sap. The institute worked extensively with protoplasts, and was successful in localization of infected cells using the ELISA technique (see RGPV, 1977). The institute was also regenerating plants from tobacco protoplasts identified as "resistant" to TMV, and had produced several mild-strain mutants from native Chinese strains using nitrous oxide. These mutants gave cross protection against TMV in tomatoes, but the future of this method of biological control for TMV in tomatoes in China was uncertain.

The institute worked on peanut mosaic virus, studying similarities and differences between strains from Beijing and Shandong Province, and on soilborne mosaic from Shandong Province, barley stripe mosaic from Shaanxi Province, and pepper mosaic from northeast China. The strain of peanut mosaic from Shandong Province was a rod, but the "strain" from Beijing was a flexous rod and was more virulent. The strain of pepper mosaic from northeast China was similar to TMV in morphology whereas the "strain" of pepper mosaic from Hebei province was a spherical virus. The institute had confirmed Robert Shepherd's work in California by showing that cauliflower mosaic in China was also a DNA virus.

The institute also worked on fungal viruses, including a virus of *Penicillium crysogenum*. The staff showed electron microscope photos of the spherical particles (see FVRG, 1976), and had confirmed that virus-infected strains of this fungus grew the slowest and produced the most antibiotic. The virus had been confirmed by the institute to be double stranded RNA (dsRNA). The staff had also isolated a spherical particle virus from *Lentinus edodes*, a popular edible mushroom in China, and a dsRNA virus from *Piricularia oryzae*--four different strains. The institute had no information on the influence of this virus on *P. oryzae*. The staff observed that *Endothia parasitica* was "*the* famous virus in a fungus."

The institute also had initiated work on the curling stunt of sea tangle (*Laminaria japonica*). This disease, according to some staff photographs, was caused by a mycoplasma-like organism (MLO)--a spiroplasma. According to the institute staff, this was the first demonstration of MLO in algae. The organism resembled the organism responsible for corn stunt, and the citrus stubborn disease.

The Mycology Laboratory covered mainly taxonomy and classification, including studies on myxomycetes, powdery mildew, yeasts, rusts, polypores, lichens, *Verticillium*, *Fusarium*, *Penicillium*, *Aspergillus*, and *Cercospora*.

The main hosts of *Verticillium* in the People's Republic of China were cotton, eggplant, cucumber, pepper, tomato, sunflower and potato; only *V. dahliae* was a problem, not *V. albo-atrum*.

Several varieties of cotton were available in each province to reduce Fusarium wilt, although apparently some were not popular. In contrast, resistance in cotton to Verticillium was another matter--apparently not available. There were three races of F. oxysporum f.sp. vasinfectum. The institute was about to produce a list and taxonomic treatment of the Fusarium of China.

TONGHUA REGION, JILIN PROVINCE, JULY 12

On Thursday, July 12, the delegation visited the Biological Control Experiment Station and the Silkworm Production Station of Liuhe County, Tonghua Region, and a cornfield in Liu Shuchen. The following are notes of these visits.

Liuhe County Biological Control Experiment Station

The Liuhe County Biological Control Experiment Station was established in 1974, and had a building area of 1500 m^2 and a staff of 11 technical cadres and 29 workers. The major crops of Liuhe County were rice (the main crop), soybeans, and corn; medicinal herbs were also grown.

The principle missions of the station were (1) to popularize biological control among the people (that is, to implement and facilitate implementation of biological control programs at the commune and lower levels), and (2) to conduct biological control research. In order to accomplish these missions, the station: (1) Gathered and stored oak silkworm cocoons to provide host eggs for Trichogramma production, (2) provided Trichogramma for workers at communes and lower levels, (3) trained technicians for communes, (4) fore-casted population trends of the corn borer as a guide for timing Trichogramma releases, and (5) provided advice and other technology to the masses.

There were ample numbers of oak trees and oak silkworms (Antheraea pernyi) produced in the county; the latter provided good host egg material for Trichogramma production. Trichogramma work in the county was done at three levels. Cocoons of Antheraea were collected, transported back to the station, and stored at low temperatures at the county level; that is, at the station. Trichogramma was also stored at the county level. Propagation and distribution of Trichogramma was accomplished at the commune level and releases were made at the brigade level. The station supplied oak silkworm eggs and Trichogramma stock (starter) cultures to three communes. In the brigades, a single person was responsible for releases of Trichogramma on an area of 40 to 50 mu. Thus, they relied "on leadership of the masses and on local self reliance" for control of corn borers.

The topography of Liuhe County consisted of rolling hills and some fairly steep hills. There were 790,000 mu of cultivated land in the county, of which 630,000 mu were dry land; that is, not irrigated. Corn occupied 350,000 mu in the county. The "European" corn borer had been a very serious pest in this area, with an average infestation of 200 larvae per 100 plants, with 80 percent of the corn plants being seriously damaged. (The highest infestation levels recorded were 30 to 40 corn borers per plant.) These infestations had resulted in an estimated 7,000,000 kg reduction in corn yield in the county.

Biological control of the corn borer by periodic release of *Trichogramma* was initiated in the county apparently in 1963 on a small scale; large-scale releases began in 1973. Depending upon pest forecasts, three releases of *Trichogramma* were made each season. The first release was "preemptive." Subsequent releases were made on an "as needed" basis. About 5000 *Trichogramma* per mu were released each time, for an annual total of 15,000 to 20,000 per mu. Releases were made at five points per mu. One person could make releases in 40 to 50 mu. For releases, the parasitized host eggs, glued to a card, were pinned to the underside of the corn leaf sheath.

The station had worked with three species of *Trichogramma* in the county: *T. dendrolimi*, *T. ostriniae* and *T. "australicum"* (=*confusum*). In 1979 the station had relied solely on *T. dendrolimi* for propagation and control. The rate of corn borer egg parasitism after wasp releases almost always exceeded 70 percent.

Since large-scale parasite releases were begun in 1973, the area under control with *Trichogramma* had developed as follows: 15,800 mu in 1973, 51,000 mu in 1974, 200,000 in 1975 and 1976, 250,000 mu in 1977, 286,000 mu in 1978, and 230,000 mu in 1979. Releases were not made if the overwintering corn borer generation was less than 20 larvae per 100 plants, which was the case in 1979. Thus, the area of release for 1979 was less than in 1978. In 1973, the overwintering corn borer population averaged 166.6 larvae per 100 plants, as compared to 28.7 per 100 plants in 1979. Thus, an overall reduction of 83.4 percent was attributed largely to the area-wide and unrelenting pressure from the *Trichogramma* release program of the past 6 years.

The station was a control forecasting station for the county and had established a forecasting network. Specialized county employees were in charge of pest forecasting. The station operated four "forecasting points" in four communes within the county. There were a total of 60 forecasting points in the county (the others being operated by the communes) which formed a network to trigger and direct the releases of *Trichogramma*. Six years of experience had demonstrated that a high correlation existed between the theory and the accomplishments of this forecasting program.

The station had established procedures for propagation of *Trichogramma*:

1. Storage of host cocoons. The host cocoon storage facility was built into the side of a steep hill. It consisted of three rooms, each 36 m^2. The roof of the building was framed with oak and covered with steel. The ceiling was covered with a soil layer 1 m deep, which in turn was covered with rice hulls (60 cm in depth). A number of ventilators protruded from the soil through the rice hulls into the attic. In the winter the rice hulls were removed thereby allowing the soil to freeze. Before the spring thaw, the rice hulls were replaced to keep the ground frozen throughout the spring and into the summer. About 25,000 kg of oak silkworm cocoons (100 cocoons per kg) could be stored within each room of the storage facility. Some 2.5 to 3 million oak silkworm eggs could be produced from the cocoons in each room. The cocoons were collected from the field and transferred to the rooms in November and then taken out in March.

2. Separation of female host cocoons. A machine had been developed at the Station that separated the oak silkworm cocoons both on the basis of size and weight. Accuracy of separation was greater than 70 percent. One machine was adequate for meeting a third of the host cocoon needs of the county, saving much manpower. A screen was used to eliminate the smaller of the male cocoons. However, size was not a reliable diagnostic property. Female cocoons were usually heavier than 8 g and male cocoons were usually lighter than 8 g. Therefore, a balance mechanism was used for the second phase of separation. The balance mechanism appeared to be a metal blade which flexed under the weight of the female cocoon.

3. Host adult emergence. An incubation room was used to accelerate adult moth emergence. In this room 230 oak silkworm cocoons per string were suspended in "double rows" from the ceiling. Within a doublet the strings were 20 cm apart. The distance between doublets was about 70 cm. The cocoons were held at 28° C and 70 percent RH for 20 days. (The normal ambient temperature was 18° to 22° C; therefore, heat had to be applied to achieve 28° C.) The emerged moths were handpicked off the string as they emerged and were placed in a basket for transfer to the egg extractor. Any remaining male moths were killed immediately. (Apparently, workers were not protected against the inhalation of moth scales.)

4. Machine collection of host eggs. This machine, manufactured at the station, could grind up to 80,000 female moths per day, producing 120 to 130 kg of eggs per day (at about 200 eggs per female). The machine replaced the labor of more than 20 persons per day, and produced enough host eggs to produce 400,000,000 *Trichogramma* per day (at about 50 to 60 *Trichogramma* per host egg). The egg extractor ground the virgin oak silkworm females, washed the eggs from the grinder, while a screen retained other larger body particles. The eggs sank in the water while lighter debris was decanted in the overflow. The eggs were then removed from the trough and transferred to a centrifuge that had a radius of about 15 cm and spun at 1480 rpm. The eggs were dried in 2 kg batches for about 10 minutes. The centrifuge had a large conical core which ensured that the eggs wound up on a peripheral cloth.

5. *Trichogramma* stock room (or "mixing room"). Glue (four parts gum to one part water) was used to hold host eggs on ca. 18x23 cm paper sheets, or "cards." One sheet held 80 g, or about 300 eggs. To raise *Trichogramma* stock for the propagation program, some host eggs on yellow sheets (cards) were placed in a darkened parasitization chamber with *Trichogramma*. New stock of *Trichogramma* was brought in each year from another host moth collected in this area. (The host species was likely a species of *Dendrolimus*; *T. dendrolimi* did not naturally occur on *Ostrinia*.) The egg sheets (10 to 15) were then placed on edge in boxes (about 25x10 cm) until 20 percent of the eggs were seen to have *Trichogramma* crawling upon them. (The boxes were inspected every two hours.) At this time these sheets were removed to the propagation room.

6. *Trichogramma* propagation room. There were two very similar methods used for *Trichogramma* propagation. The difference was in the type of chamber or box used for parasitization.

Type A, or "big box," was 1.2x3.0x0.6 m and covered on one side with transparent polyethylene. About 20 yellow stock cards of parasitized oak silkworm eggs were attached to the back wall. White cards with

unparasitized eggs were suspended from a string strung across the front of the box. A fluorescent light was used to attract the emerging adult parasites; that is, Trichogramma emerging from the parasitized eggs at the back of the box were attracted to the light and consequently discovered the unparasitized eggs at the front of the box. This box produced 20 million Trichogramma per day. The temperature varied from 20° to 25° C.

Type B, or "big chamber," was essentially the same as type A, except that the box was a walk-in chamber, 3x4.3x1.2 m in size. The chamber took 144 white cards, which were attached to six strings strung horizontally along the transparent polyethylene front which faced a window. Numerous (408) parasitized egg cards (yellow stock cards) were attached to the opposite opaque wall. Natural light from the window was used to attract the wasps onto the unparasitized eggs. The chamber produced 140 million Trichogramma per day. The stock cards and new host cards were placed further apart than in the "big box" so the Trichogramma adults had to fly further to find fresh hosts. This eliminated weaklings; only strong fliers could reach and parasitize the eggs.

In either case, the cards were checked every 2 hours and when 70 percent of the host eggs were observed to have parasite adults on them, they were removed to a darkened room where they were laid horizontally on shelves for 24 hours behind a dark curtain. This practice apparently ensured that the parasites stayed with the eggs so that consistent rates of parasitization and numbers of parasites per egg were obtained. Next, the parasitized egg cards were stored for 12 days in an incubation chamber at 25° C and 70 percent RH. The parasitized eggs were then ready for delivery to 14 locations in the county for field application. Fresh stock cards were placed in the propagation boxes every 3 days. Also, honey-water was lightly sprayed on the sides of the boxes to provide food and moisture for the adult Trichogramma.

The Trichogramma culture was totally replaced annually with field-collected parasites, as noted in the above discussion of the stock room. Quality of the culture was further assured by forcing the parasites to move from the parasitized eggs to unparasitized eggs, a move of more than one meter. Additionally, consistent parasitization of the eggs was guaranteed by removal of the eggs -- when 70 percent of the eggs had parasites on them -- and their transference to a darkened room. This reduced superparasitization of some eggs and guaranteed parasitization of most of the eggs. It undoubtedly took a long time for Trichogramma dendrolimi to penetrate the egg chorion of the oak silkworm; thus, the darkened room allowed ovipositor "drilling" without disturbance.

7. Corn borer forecasting data room. The station had a series of charts lining the walls of this room. The graphs showed the timecourse of rainfall and number of corn borers per plant. Only rainfall data for May, June and July were included. The data were collected between 1973 and 1978, inclusive, and showed that borer survival was greatly favored by high levels of rainfall. When the cumulative amount of rainfall (in cm) in the critical months of May through July was high, the corn borer population (in larvae per 100 plants) was high.

The Station's forecasting program was based on three factors: (1) Number of overwintering corn borer larvae and the date of their pupation, (2) temperature, and (3) amount of rainfall (and humidity); and the effects of the latter two factors on the first.

Using the above factors, the date of initial oviposition of Ostrinia in the field was forecasted, as follows: (1) Percent pupation by overwintering larvae was monitored on a daily basis, (2) the date when 20 percent of the larvae had pupated was determined, and (3) 11 days were added to this date to forecast the onset of oviposition (when it was estimated that there would be one or two egg masses per mu). One graph showed the forecasted dates and the actual dates of initiation of oviposition for the years 1974 through 1978. In no case did these values differ by more than 3 days.

The first release of Trichogramma was made on the day of predicted first oviposition; the second release was made 5 days later; and the third, and last, release was made another 5 days later.

8. Storage room for Trichogramma. The station had two cold storage rooms in which parasitized eggs and unparasitized eggs could be stored for up to 1 month at 0° to 5° C.

Silkworm Production Station, Liuhe County

The "Station for Production of Oak Silkworm" was under the jurisdiction of Tonghua Region. The station was established in 1966, but was not fully operational until 1970. It had a staff of 105, of which 45 percent were women.

The station had two missions: (1) Mass production of the mulberry silk- worm, Bombyx mori, for silk production; and (2) mass production of the oak silkworm, both for silk and to provide cocoons for Trichogramma rearing. Total area of the station was 3940 mu (including building and field areas), of which 1200 mu were used for the culture of oak trees and oak silkworms.

The area of oak culture and oak silkworm production that could be managed by one person was expressed in a unit called a "ba"; one ba varied from 40 to 50 mu. To meet the production needs of 1979, the silkworms were being produced in four batches. Production was underway on 17 ba in 1979.

Fertile eggs of the oak silkworm were applied at the rate of 1.5 kg per ba of small oak trees. There were about 250 oak trees per mu. The trees were continually pruned to maintain a height of about 1.5 m and to produce maximum foliage. In the spring two ba of oak silkworms were established and in the autumn an additional 15 ba were established with eggs obtained from the spring generation.

Three types of oak silkworms were reared at the station: (1) The "xing-huang" type (greenish-yellow larvae); (2) the "jing-yi" type, apricot-colored, most voracious, and produced the most eggs; and (3) the "onze" (?) type, which was black. The three types of oak silkworm could be crossed in all combinations. However, egg viability varied from cross to cross, indicating that in nature these types might not freely interbreed. The

larval genomes differed in developmental rate, size, and egg production; for example, one required 50 days to develop and another required 48 days at comparable temperatures. The trees had been infested with eggs from the xing-huang type on June 30 and the onze type on July 8. On July 12, the xing-huang type were in the third instar and the onze type were only in the first. Nevertheless, both were scheduled for harvesting in mid-August.

About 200 eggs were placed on each small tree, with excess larvae being removed in the second instar. A larva could increase in size by a factor of 1.4 per day. After larvae had entered the fifth instar, a small tree (1.5 m) could support only 10 individuals. Thus, the larvae were dispersed manually by clipping off leaves with larvae and placing them on adjacent trees to obtain an even infestation. The young larvae preferred small leaves while the older larvae sought out the older leaves. Only 48 hours were required for spinning the cocoons, which were then removed from the trees by hand. After 4 to 6 days, the adult emerged from the cocoon. Mating and oviposition took place indoors at the Station.

The oak silkworms had four types of pathogens: (1) Two kinds of virus (the most serious pathogens; no samples were available) which caused a wilt disease, and were "very resistant"; (2) a bacterium which caused cessation of feeding; (3) a microsporidan, which was transmitted transovarially, and which caused "microgranulosis disease"; and (4) muscardine fungi (red, green, and white, which occurred mainly in the cocoon stage).

Other insects attacking oak in the area included may beetles and cerambycids, but no *Lymantria dispar*. *Rumex* was seen en route to the station.

Liu Shuchen Township, Liuhe County

In 1974, a brigade of a nearby commune in Liu Shuchen (Willow Township) began releasing *Trichogramma*. Wasps were released in 2700 mu of corn. In 1974, there were in excess of 100 overwintering corn borer larvae per 100 plants. In 1979, after 5 years of releasing *Trichogramma* there were about 20 larvae per 100 plants and parasitism ran at 63.4 percent.

Five release points per mu were used; that is, a release point every 132 m^2. *Trichogramma* were placed on every eleventh row of corn near field margins, but at 20-row intervals further within the field. The parasitized egg cards were pinned to the underside of the leaf sheath.

The delegation noted or collected a variety of coccinellids, *Chrysopa*, *Aphidius*, syrphids, braconid parasites of noctuid larvae, and aphids in soybeans and corn in the area (see Appendix 5). Some of the potatoes in one four-row "private plot" were severely infested with early blight caused by *Alternaria*, while an adjoining four-row family plot of potatoes showed almost no sign of disease. Evidently, one family had used a susceptible variety of potato and different planting dates. The commune produced its own seed, certified by its own specialists. The disease was not a problem in the commune's regular plantings. The disease epidemics in commune fields would evidently be treated with fungicides.

CHANGCHUN, JILIN PROVINCE, JULY 13

On Friday, July 13, the delegation visited the Changchun Institute of Applied Chemistry of the Chinese Academy of Sciences. The following notes are from that visit.

Changchun Institute of Applied Chemistry, CAS

The institute was first established in 1948 as a comprehensive research institute for mechanics, physics, chemistry, and so forth In 1952, the institute began to focus more on chemistry and some of its departments were merged into the physical chemistry institutes in Shanghai. In recent years the institute had strongly related its program to economic problems of the People's Republic of China.

The institute had 650 workers; more than 40 percent were women. It had three Departments: (1) Polymer Chemistry and Physics, (2) Physical Chemistry, and (3) Inorganic and Analytical Chemistry.

Polymer Chemistry and Physics Department. Most investigations in this department focused on rubber because the People's Republic of China produced very little natural rubber. However, the People's Republic of China had substantial supplies of isoprene and butadiene. Thus, the synthesis of cis-1, 4-polybutadiene was a major accomplishment. In this research, the institute did not use nickle and titanium catalysts (which were used in Japan and in the the United States). Instead, the institute used a variety of rare earths which were abundant in the People's Republic of China. Research was also conducted on (1) "functional" and thermostable polymers, (2) modification of polymers by radiation, (3) relation of polymer structure to performance, and (4) combined thrusts on synthesis of polymers and on the physical properties of the products.

Physical Chemistry Department. The main thrusts of this department were as follows: (1) Structure of materials including polymers and sex attractants of animals; (2) design and construction of instrumentation such as mass spectrometers, X-ray diffractometers, and others; (3) catalysis -- multiphasic and homogeneous (this was combined with petroleum chemistry -- main catalysts were rare earth elements); (4) electrochemistry and metal corrosion (corrosion was a major economic problem in the People's Republic of China); (5) physical chemistry of semi-conductors including latent electric semi-conductors, gas conductors, and studies with cadmium sulfide and silicon; and (6) chemistry of leather in order to achieve separation of isotopes.

Inorganic and Analytical Chemistry Department. The main thrusts of this department involved the rare earths, including methodology for ready separation of 15 rare earth metals, development of analytical methodology, and application of rare earth elements in the manufacture of new industrial materials.

In addition to the above, the institute was considering the possibility of a new thrust in herbicide chemistry.

Synthetic High Polymers Laboratory. The laboratory conducted studies on the stereospecific polymerization of butadiene and isoprene to form cis-1, 4-polybutadiene with good physical properties. From 1964 to 1971, the staff used nickle naphthenote as the catalyst which gave excellent processing and mechanical properties, and was adopted by all rubber plants throughout China. Subsequent work was focused on the use of trialkyl aluminum and rare earth catalysts to give high yields (96 to 98 percent) of cis-1, 4 polymer. Reaction rates had been low. But, 10 other catalysts including diethyaluminum chloride had very high stereo- specificity and high catalytic activity. Polymers with molecular weights in the millions (for example, 10 million) could be obtained; that is, a greater molecular weight than natural rubber. The rare earths determined the percent yield of cis-1, 4 polymer. N_d had the highest polymerization activity whereas Eu, Er, T_m, and others had poor activity. The 4f orbital had been found to take part in bond formation. Indeed, results could readily be predicted from molecular orbital theory. AlR_3 (where R = alkyl group) had ligands which bond to rare earth metals; but microstructure of polymer molecules was not affected by composition of AlR_3. The isoprene-polybutadiene polymers had excellent low temperature properties. At -60° C and -70° C they were still elastic and as good as the best commercial polymers from the USSR, the United States, and Japan.

X-Ray Diffractometry Laboratory. The laboratory had just completed a major work on the structure of polymers of tetrafluoroethane (that is, teflon) and on hexafluoropropylene. One technique used to study crystalline structure was "small angle light scattering." At 19° C the molecule was in a dynamic equilibrium between two non-helical configurations. At higher or lower temperatures the $C_2 H_4 F_2$ polymer had a helical structure. Also, when hexafluoropropylene constituted from 2 to 22 percent of the copolymer, the latter was helical. This was investigated in copolymers that had been formed by inversion, dispersion, and suspension processes. The copolymers did not expand or contract with changes in temperature. However, the lattice spacing was greater for those formed with the immersion and dispersion process than with the suspension process. This was so because the distribution of the monomers along the chain was respectively different. The copolymers in which the monomers were uniformly distributed showed the greatest response to temperature.

Polarographic Analysis Laboratory. The goal of this laboratory was to develop analytical methods to quantitatively describe the presence of unknown chemicals in water. Indeed, it had devised a water quality monitoring instrument. The staff were working with a rotating glass electrode, and applying principles of electrochemistry to ion selection.

Physical Properties of High Polymers Laboratory. This laboratory was engaged in stress-strain studies of rare-earth catalyzed synthetic rubbers and of natural rubber. They showed graphs relating yield strength to viscosity. The resistance to deformation regardless of temperature could be explained on the basis of entanglement of molecular chains. Much of the work was done at extremely low as well as at high temperatures. All of the rather sophisticated instrumentation had been designed and assembled by the Laboratory.

NMR Spectroscopy Laboratory. This laboratory had nearly completed the construction of a 100 MegaHertz Fourier-Transform Nuclear Magnetic Resonance Spectrometer. It used a domestic computer similar to the Nova 1200.

GC-Mass Spectroscopy Laboratory. This laboratory had a JEOL JMS-100 GLC-Mass Spectrometer. It had worked with the Zoological Institute, Beijing, in identifying the three components of the sex attractant of the pine caterpiller moth, Dendrolimus. The methods used had involved (1) cutting abdominal segments with ovipositors and pheromone glands, (2) making extracts with ether or dichloromethane, (3) using low temperatures to "crystallize-out" fatty acids, (4) separating active components on a column, (5) using of an electroantennogram technique to identify active peaks, and (6) using GLC-MS for structural elucidation of active fractions.

The laboratory had also synthesized the two pheromonal components of the "European" corn borer. Regardless of the ratio of these two components, they proved unattractive to the "Chinese European corn borer." Recently, the laboratory had succeeded in identifying two components of the pheromone of the "Chinese European corn borer." The laboratory planned to begin a study of the pheromone of the grassland moth, Gynaephora "ginghainensis" (a lymantriid).

Work on application of GC-MS in environmental analysis was undertaken in 1976. Initially, the approach had been to "survey" for organic chemicals in river water, well water, rain, and so forth. A major project was underway in studying pollution in the Songhua Jiang (Sungari River). Evidently, substantial concentrations of aromatic halides were found to be present in this major river. The pollutants were being traced back to industrial plants as the major sources.

CHANGCHUN MUNICIPALITY, JILIN PROVINCE, JULY 14

On Saturday, July 14, the delegation visited the Jilin Province Forestry Research Institute, and held a discussion on plant pathology with a group of People's Republic of China plant pathologists. The notes on the visit and the discussion are presented below.

Jilin Province Forestry Research Institute

The Jilin Forestry Research Institute, established in 1956, was under the direction of the Forestry Bureau of Jilin Province. The overall theme had been to mold basic and theoretical work into forest production and protection practices. and the forestry specialists worked closely with the masses to accomplish this theme. The work of the institute was partitioned into four thrusts as follows: (1) Afforestation, (2) forest protection, (3) forest machinery, and (4) forest production and preservation. The institute had seven laboratories, or divisions, and 180 staff members, about 50 percent of whom were involved in scientific research programs. As far as biological control research was concerned, Trichogramma amd Anastatus wasps were studied for use in protecting forests. Dendrolimus species and Lepidosaphes ulmi were considered to be some of the main pests. (See Appendix 9.)

The Biological Control Division worked on the production of *Trichogramma dendrolimi* on the oak silkworm, *Antheraea pernyi*, with special emphasis on technology transfer. In 1964, this institute discovered that eggs of the oak silkworm could be used as a *Trichogramma* laboratory rearing host, and also that unfertilized eggs could be readily extracted from virgin oak silkworm females for this purpose. In recent years, production and field effectiveness had increased, and the use of *T. dendrolimi*, laboratory-cultured on oak silkworm eggs, had increased throughout the People's Republic of China.

The institute had also found that the rate of parasitism was an important consideration in deciding upon the number of wasps to be released per mu and upon the frequency of releases. The fecundity of *T. dendrolimi* differed according to the laboratory host. With oak silkworm eggs, one *T. dendrolimi* could produce an average of 112 eggs, and could parasitize five host eggs. This was the basis for application of the species.

In Jilin Province, *Trichogramma* was applied for several different pests. Because of differing rates of attack and fecundity, different densities of *Trichogramma* had to be used according to the target pest. (The forest insect pests against which *Trichogramma* was used in the Province was not made clear, though they probably were primarily *Dendrolimus* species; see Hsiao, 1981, for a good summary of the use of various biological agents for the control of *Dendrolimus* in China.)

The staff stressed the importance of taking into account the density of the host eggs in the field when analyzing parasitization data. Female fecundity ("maternity"), percentage mating, and male:female ratio must be taken into account prior to release. Some mating occurred before *T. dendrolimi* emerged from the oak silkworm eggs. One had to consider the number of females released, not just total number, including the number producing eggs and number fertilized. Unmated females were parthenogenetic and produced males only. Under good rearing conditions, 90 percent of the progeny were females and 10 percent were males. However, only 63 percent of the females were capable of ovipositing. There appeared to be a real emphasis in obtaining recycling after release; that is, inoculative releases.

Fecundity was affected by temperature, humidity, light and nutrition. Indeed, supplemental nutrition for adult *Trichogramma* made a big difference. When they were fed on honey, an R index of 23.4 [R was not clearly defined] was observed. Without honey, only 45 percent could lay eggs. However, under optimal management practices, 72 percent to 75 percent of females laid eggs versus 45 percent under poor conditions. The staff emphasized the importance of (1) raising the "maternity" rate [number of progeny per female], (2) skewing the sex ratio in favor of females, and (3) raising the percentage of females capable of oviposition.

Adult nutrition was also important in regard to fecundity; addition of honey for adults increased the "maternity rate" by 45 percent. Honey was sprayed on host eggs prior to field release for the emerging *Trichogramma* adults.

The institute had a chart illustrating oviposition and survival rates for T. dendrolimi. The percentages of eggs laid by a female were 20, 80, and 93 at 12-, 24-, and 36-hour post-adult emergence, respectively; that is, about 95 percent of the eggs were oviposited by T. dendrolimi females in the first 36 hours. Egg laying began within 3 hours after emergence. The median survival time (LT_{50}) for adult females was 60 hours.

The institute had conducted no work with insect pathology, but it was involved in the use of Anastatus bifasciatus [=japonicus] against Dendrolimus superans, a major pest of larch in the province. Malacosoma neustria was the major oak pest in the area. Ocneria [=Lymantria] dispar was present on larch, oak and many other trees in the area, but only occasionally defoliated small areas; it was not considered a pest. (See also list of forest insect pests, Appendix 9.)

The institute's method of rearing oak silkworm moths for egg collection (by grinding and water extraction) was similar to the procedures observed in Beijing and Liuhe. Parasite inoculation of the eggs was done without light to avoid differential parasitism caused by the effects of light. For emergence of host moths, cocoons were placed in a monolayer on shelves 0.7x1.0 m. A wooden frame was inserted above each shelf with a string wound through holes in the frame to cross the 1 m span 10 times. Pieces of cloth were suspended from the string into the tray containing cocoons at 7.5 cm intervals. The emerging adults climbed onto the cloth strip where they could be easily removed for egg extraction. The host eggs were placed on trays in a cabinet 2 m high and 1.2 m wide with seven shelves and three trays per shelf. It was in this cabinet that the eggs were infested with T. dendrolimi.

The institute also studied Dendrolimus moths (to compare the weight of pupae with the fecundity of the emerging female), and cultured Anastatus on oak silkworm eggs (one parasite per host egg).

Discussion of Plant Pathology

Plant pathology was a special topic for discussion with plant pathologists from Jilin Agricultural University, Jilin Province Plant Protection Institute at Changchun, the Plant Protection Institute at Gongzhuling, and the Jilin Province Vegetable Research Institute. A number of crops and diseases were identified, as follows.

Soybeans. The soybean cyst nematode, Heterodera glycines, was rarely a problem in Jilin Province, in spite of widespread cultivation of soybeans there. In fact, this province had grown soybeans for an unknown number of centuries and may be the home of this crop. The only place troubled by H. glycines in Jilin Province was in the Baicheng Region, in the western part of the Province, where the soils were more alkaline and sandy. The nematode was also a problem in the northwestern part of Heilongjiang Province, and had been reported from parts of north China. Some institutes in Heilongjiang Province had recently begun to work on H. glycines. Areas not previously known to grow soybeans, or where the crop had more recently been introduced, were the areas having nematode problems. (The lack of trouble from the soybean cyst nematode in an area considered the "home" of soybean, suggests that soils in this area might be an area for exploration

for natural enemies of H. glycines.) The main control for H. glycines in 1979 was to rotate soybeans with sorghum, corn or millet. Organic manuring also helped keep the nematode in check.

Soybean rust was reported only occasionally in northeastern China, but was serious in Fujian Province in the south. Some studies were made of Septogloeum sojae, the cause of a disorder known as "sleeping" disease of soybean, because the leaves turn down. Like soybean rust, this disease did not occur in the United States. Phytophthora parasitica var. sojae was not a problem in China; in fact, the pathogen was said to be unknown in the country. On the other hand, Jilin Province had 30 of the 50 known diseases of soybeans. Rhizoctonia solani was the major root disease of soybeans.

Peanuts. This subject came up in connection with nematodes. The root knot nematode had been reported in Liaoning Province on peanuts.

Nursery trees. Tree seedlings were presumed to be used for wind breaks as well as for reforestation. The main problems encountered are described as the usual Pythium debaryanum, Rhizoctonia solani and Fusarium species. These pathogens were very important throughout China in the 1960's. Some primitive controls were apparently still being used in 1979, including disinfection of seed and soil with ceresan, $FeSo_3$ as a drench into the soil, and even the use of dilute H_2SO_4. The latter was to drop soil pH to help control Pythium.

Timber trees. Armillaria mellea was an important disease in Heilongjiang Province where it was controlled by thinning out the infected trees and digging trenches around infected areas to confine the fungus and its rhizomorphs. The main hosts were Pinus [aurea?] and larch. Fomes annosus, F. pini, and F. polyporus(?) were also described as important pathogens on trees in northeastern China. Apparently, some work had been started at Beijing on biocontrol sensu J. Rishbeth, whereby Peniophora gigantea was established on freshly cut stumps to prevent F. annosus.

Rice in Jilin Province. Apparently the most serious problem on rice in this colder, drier region of China was a seedling blight caused by Fusarium moniliforme (and F. oxysporum), Rhizoctonia solani, and an unidentified Pythium species. The disease appeared as a lesion at the soil line, causing the plant to break over. Symptoms appeared when plants were in the 3- to 4-leaf stage. Infected seedlings also had needle-shaped leaves. To control this problem of rice, several measures were used. The fields were covered with a 3-cm-thick layer of "rich" virgin soil, not mixed in. This soil came from the nearby mountainous areas and was probably pathogen-free and of lower pH. The actual pH difference was about 2.0 units; 7.0 in the cultivated soil and 5.0 in the virgin soil. In addition to the soil layer, every rice row was started beneath a plastic cover (like a long, narrow tent) for the first 40 days. Without this cover, the temperature was too low for rice in this Province, which was probably why it was attacked by Pythium. If these practices did not control the disease entirely, the problem was generally solved once the field was flooded. Apparently, the seedling blight was due to a combination of water stress and cold soil. If all these failed, Dexon was applied at the rate of 2.5 kg per 1000 m^2. About 30 percent of the acreage was treated with Dexon.

Vegetables. The Vegetable Research Institute of Jilin Province, was especially interested in biological control methods for vegetable diseases, specifically for Fusarium wilt of cucumber and Verticillium dahliae on several crops. Among the most important diseases of vegetable seedlings were damping-off of eggplant, cucumber, tomato, and pepper, caused by Pythium spp. and Rhizoctonia solani. PCNB was used in Jilin Province to control Rhizoctonia. On cabbage, Phoma lingam was an important problem.

Corn, sorghum and millet. The northern leaf blight (Helminthosporium turcicum) which occurred in northeastern and north China had become a serious problem on corn with the popularization of hybrids, much as occurred in the 1940's in the United States. Rhizoctonia was a problem on young sorghum plants, and occasionally Fusarium oxysporum occurred on sorghum seed. On millet, F. avenaceum might cause a root rot; this fungus also attacked soybeans under certain conditions.

SUZHOU REGION, JIANGSU PROVINCE, JULY 17

On Tuesday, July 17, the delegation visited Wu County Institute of Agriculture, Suzhou Region, and held a discussion with PRC scientists on plant disease control in Suzhou Region. The following are the notes of the visit and the discussion.

Wu County (Wuxian) Institute of Agriculture, "Plant Protection Station."

Suzhou Region had eight counties under the direction of the regional agricultural bureau. Suzhou city was under the direction of the Jiangsu provincial administration. The cultivated area of the region was 6,700,000 mu. The autumn crops were rice (5,710,000 mu) and cotton (705,000 mu). The summer crops were wheat (3,600,000 mu), rape (800,000 mu), and green manure crops (1,700,000 mu)--primarily vetch. The green manure was composted before it was incorporated into the soil. The annual rotation of wheat-rice-rice occupied 60 percent of the land area. The index of multiple cropping was 240 percent. Yields in 1978 were as follows: rice -- 533 kg/mu; rape -- 123 kg/mu; wheat -- 285 kg/mu; and cotton -- 71 kg/mu (average cotton yield was 55-66 kg/mu).

Cotton was the commodity requiring the preponderance of insecticides. The most important cotton insects were aphids and the pink bollworm, Pectinophora gossypiella (both of which were serious every year); and the bollworm, Heliothis armigera, and the red spider mite Tetranychus bimaculatus (which were serious in some years but not in others).

The station, established in 1972, had 112 mu for experimental plots, and a staff of 84 organized into four groups: (1) Plant protection (with five scientists, four technicians, and five other workers); (2) seed selection and culture; (3) crop culture; and (4) soils and fertilizers. Some studies were done on barley culture, and some research was conducted in plant protection. The three objectives of the plant protection studies at the station were to: (1) Obtain information on major pests, losses, and pest population fluctuations; (2) develop and train plant protection technicians and skilled workers (for the communes); and (3) study the principles that governed pest outbreaks and the use of this information in

devising methods, systems and strategies of pest control. In addition, the station assembled information on climate and other factors that could be useful in solving future pest problems.

The station had an elaborate pest monitoring and forecasting program (primarily in rice).

1. Area of pest monitoring. Personnel of the station worked with nearby brigades involving an area of 1500 mu to monitor pests. Pest problems which had to be handled on a community-wide basis were drawn to the attention of Plant Protection Groups in the communes. The communes were in charge of pest monitoring in their own areas. There were periodic consultations between the station and local communes regarding plant protection programs and problems.

2. Objects of pest monitoring. Pests in four crops were monitored--rice, wheat, oilseed crops (primarily rape), and green manure. There were 21 major pests of these crops in the area. The major rice pests were pink stemborer (*Sesamia inferens*), yellow stemborer (*Tryporyza incertulas*), and striped stemborer (*Chilo suppressalis*).

3. Methods of monitoring and approaches to field studies. Pests were monitored by the following means: (a) light traps (a 22-year data base had been accumulated); (b) sex attractants (using ovipositor extracts of virgin female pink stemborers; this work began in 1978); (c) direct observations in the field on the various developmental stages; (d) rearing of selected species; and (e) collection of data from published literature.

Field observations were made on rates of development in relation to crop development, effect of agronomic practices on pest populations, and so forth. A 21-year data base on such observations was available for the various rice stemborers. Rice diseases were also studied in the field. The principal diseases were sheath blight (causative organism -- *Rhizoctonia solani*) and rice blast (causative organism -- *Piricularia oryzae*). The principal disease of wheat was scab (causative organism -- *Gibberella zeae*). A 20-year data base on scab was available.

Much information on rice insects, including data on rates of development for various life stages, had been obtained from the rearing studies for brown planthopper, *Nilaparvata lugens*; green rice leafhopper, [*Nephotettix bipunctatus* (=*virescens*) or *N. cincticeps*?]; pink stemborer, *Sesamia inferens*; yellow rice stemborer, *Schoenobius incertellus* [=*Tryporyza incertulas*]; and striped rice stemborer, *Chilo suppressalis*.

4. Forecasting. Using the above methods, pest forecasts were developed. For example, knowledge of the occurrence of the onset and peak incidences of various life stages were considered along with information on crop phenology and weather data. After a tentative forecast had been derived, it was evaluated using information in the historical data file. Trap data were checked to see if populations were rising or falling. Check areas were maintained in which no control measures were used to evaluate (*ex post facto*) the accuracy and precision of forecasts. A typical forecast included information on beginning of pupation, peak pupation, and appropriate control measures.

5. Development and issuance of broadcasts of pest forecasts. This was done at the beginning of pupation, and at the start of adult emergence, at which time recommended methods of control were issued, usually three to five days prior to the recommended implementation. The county agricultural bureau printed this information and distributed it to the communes, and the bureau was responsible for issuing control materials to communes and brigades. In exceptional instances, a warning might be issued by radio. The warning message was developed by the scientists but it had to be approved by the county revolutionary committee.

Controls were generally chemical, though the station tried to protect beneficial insects. Synthetic organic insecticides were applied in big droplets in order to spare natural enemies. Dimethoate (Rogor) and fenitrothion (Sumithion) were the major insecticides used on rice. Evidently large acreages were rarely treated with these materials. No synthetic organic fungicides were used on a large scale on rice. Only a small portion of the wheat acreage was treated with MBC (benomyl, Benlate) for scab.

Wheat scab (Gibberella zeae) was forecast by checking the incidence of the disease when the wheat was flowering. The station formerly relied on only a count of ascospores in spore traps to predict outbreaks. By 1979, accurate rainfall data were being used in forecasting. If the wheat was flowering and infected, then it was known that 3 days of rainy weather with temperatures below 15° C would very likely produce an epidemic. Under such conditions, treatment was applied when 10 to 15 percent of the wheat was flowering. The wheat was sprayed with a fermentation product of Streptomyces hygroscopicus var. jinggagensis. Also MBC (Benlate) might be applied one or two times at 5- to 7-day intervals. In addition to the above, spore traps had been used for many years and had produced data that correlated almost perfectly with direct observations. The Streptomyces antibiotic was also used extensively to treat for sheath blight of rice. Some of this material were made at the County level and some on the communes. It was applied on 1,000,000 mu per year in the County.

No work on insect pathogens was done at the station and no insect pathogens were known there. Few observations of larval or pupal parasites had been made; Apanteles spp. occurred but they were not abundant. The station did have much information on spider predators (10 major species) and egg parasites (Trichogramma japonicum, T. chilonis and Telenomus dignus) in the county; the egg parasites were not used on a practical basis. Spiders were very important biological control agents and great pains were taken to protect them, collect them, and move them to fields where they were needed. Micryphantes [=Tmeticus] graminicola was the most important species during June through August. During the latter part of September, Clubiona japonicola became very important. Other significant species included Oedothorax insecticeps, Theridion [=Theridium] octomaculatum, Enoplognatha japonica, Singa pygmaea [=Minyriolus pusillus], and Tetragnatha praedonia.

The station performed soil analyses for eight communes. Seventy percent were Class I soils. These contained 3.0 percent humus, 0.15 to 0.2 percent nitrogen, 0.12 to 0.15 percent phosphorus, and 1.5 to 2.0 percent potassium. The station was breeding for resistance to powdery mildew of wheat, Erysiphe graminis. Spores were injected with a hypodermic needle into the flowers to study speed of development on various wheat selections.

The station also conducted laboratory studies of the emergence of pink stemborer adults for their developmental rates and for making extracts of the sex attractant. Field-collected larvae were brought to the laboratory to determine time of pupation and adult emergence.

Notes on Plant Disease Control in Suzhou Region

Antibiotics were not applied to foliage for rice blast control. Instead, "EPB" (Katazia) or in some cases MBC (Benlate or Bavistin) was used. About 200,000 mu of rice were generally treated in the heading stage. Also, less N (liquid urea) was applied at heading to help reduce blast. About 300,000 mu were treated as seed dressing with "402", an antibiotic made in Shanghai, and the dressing was to help control blast. Apparently there was a seedling problem caused by, or attributed to, *Piricularia oryzae*, possibly caused by seedborne inoculum. In general, blast was not serious in the Region.

Bacterial blight (*Xanthomonas oryzae*) was a problem in the 1960's, but was generally controlled by resistant varieties by 1979. Also, rice paddy management was important; the farmers kept the land very level to keep the water from collecting or concentrating at one end of the paddy. In addition, they did not run water from one paddy into another. They arranged the paddies side by side along a canal rather than end to end which would distribute the bacteria. The main problem from this disease occurred when there were heavy rains with a strong wind. The use of chemicals for control was limited.

Sclerotinia sclerotiorum was a problem in rape and might infect 10 to 12 percent of the plants if control measures were not taken. For control, MBC (Benlate or Bavistin) was applied at about 50 g a. i. per mu at a cost of about 1 yuan. Rape was a winter crop that competed with wheat and barley for acreage, but generally it was grown after rice rather than after cotton.

In this county, many people were involved in one way or another in the making or delivering of compost. Grass and weeds from the roadsides, canals and other places were pulled by women and girls and hauled in baskets at the ends of poles on their backs to dumping points. Some of these points were several hundred meters down the road. The compost recipe for this area was mud, green manure, and animal and human wastes. Each crop was fertilized with about 4000 kg per mu including about 2250 kg mud, 750 kg green manure, and 1000 kg animal wastes. In addition, about 30 kg urea was applied as a liquid top dress. This top dress was applied by long-handled dippers with the solution dipped from a bucket and then thrown across the paddy crop. The compost might be mixed on the road or in pits. The paddy fields had pits about 7 m in diameter, about every 100 m along the headland (end nearest the road) where the brew was incubating. The compost had to incubate for 45 to 90 days, so the mix in June-July was for the late rice crop, to be planted in August.

SUZHOU REGION, JIANGSU PROVINCE, JULY 18

On Wednesday, July 18, the delegation visited the Changshu County and the Taicang County Pest Monitoring and Forecasting Stations, the Jinkuan Antibiotics Production Plant, and the Zhi Dang and the Bai Mao Communes of Changshu County, Suzhou Region. The following are notes from these visits.

Changshu County Pest Monitoring and Forecasting Station

Changshu County was located in the northern part of Suzhou Region near Chang Jiang (the Yangtze River). The county had 33 people's communes, three state farms and one forest farm/station. Cotton and cereal crops were the major commodities. The county had a cultivated area of 992,000 mu, which, in summer, was divided among 740,000 mu in paddy rice, 203,000 mu in cotton, and the remainder in vegetables, miscellaneous grains, and medicinal herbs. Pest problems were abundant and complex. Integrated control measures were used, including biological, physical, cultural and chemical.

The station had three major missions for managing insects and diseases, with a number of major accomplishments.

1. Strengthening of preventive measures involving seed quality, and management of water, fertilizer and crop culture, and use of disease resistant plants and seed treatments. In 1978, a rice variety resistant to rice blast and sheath blight was planted on 894,000 mu. (This may explain why blast was not important in the area--the current varieties were resistant, at least temporarily. Apparently the current varieties were also resistant to sheath blight caused by *Rhizoctonia solani*, but this resistance may not have been very complete. In view of the extensive efforts at control of sheath blight with antibiotics, the resistance to this disease appeared to be inadequate.) A cultural control against the sheath blight of rice, namely, the draining of the paddy as early as possible to let the sunshine and air currents dry the plants and check the fungus, was in use. Lime was used as a seed dressing against smut and the cockle nematode, *Anguina tritici*, on 945,000 mu. A 48-hour soak in water was also used in some cases for rice as well as wheat; the anaerobic condition that developed with the grain in the water was thought to kill the seedborne pathogens. The cotton varieties Pekan #1 and #2 were resistant to *Fusarium* wilt; in 1978, 30,000 mu were planted with these varieties and in 1979, 150,000 mu were planted which constituted 75 percent of the total cotton area in the county. Suzhou Region had two races of *F. oxysporum* f. sp. *vasinfectum*.)

2. Biological control methods were used extensively in the county, including: (a) the use of *Streptomyces hygroscopicus* var. *jinggagensis* antibiotic formulation for sheath blight of rice (in 1978, this involved 1,080,000 mu-treatments, with an average of 1.5 treatments per mu annually); (b) the use of ducks for control of rice insect pests (in 30,000 mu of rice in the county); and (c) the use of the parasite *Dibrachys cavus*, which was cultured and released annually in cotton storage areas to control pink bollworm (about 20 to 30 million were released annually, with a consequent reduction in pink bollworm of about 40 to 50 percent).

3. An important mission of the station was to popularize the scientific application of chemicals and to improve preventive technology.

All of the above measures guaranteed a bumper harvest in 1978 of 548 kg per mu of rice which was an increase of 11.5 percent above the previous record yield. The county total was 402.5 million kg which was 10.4 percent above the previous record. The average yield of double and triple cropping was 781 kg per mu, or 10.8 percent above the previous record.

Experiments with Bacillus thuringiensis (B. t.) were being conducted at the Station, but B. t. was not yet being used for control to any large extent. There was no work with Trichogramma at the station, as Trichogramma was not used in the Region at all because of the absence of host material for culture. Corcyra cephalonica was a quarantine pest in the Region (it is a rice storage pest) and could not be used. The oak silkworm, Antheraea pernyi, did not occur in southern China, and the mulberry silkworm, Bombyx mori, could not be used as a host because, to obtain adult moths for egg production, the silk cocoon was ruined. (Apparently, both the oak silkworm and the mulberry silkworm severely damaged the silken threads upon emergence from their cocoon; but see notes for July 8. Both species were used for silk production, but B. mori was much the more generally used, particularly in Suzhou Region, where A. pernyi did not occur naturally. To obtain silk, the silkworm cocoons were placed in boiling alkali-water.)

The main rice pests in the county were pink, yellow, and striped stemborers. Parathion was used for these, though sex attractants (for pink stemborer) were applied at 100 points in the county. The most important single method for controlling stemborers was to prevent overwintering by pulling up and composting all the rice plants. This was effective because the immature forms overwintered in the stems at the soil-air interface.

Major pests of cotton in the county were the pink bollworm, bollworms (Heliothis), and spider mites. The pink bollworm had three generations a year in the area. Gossyplure was used to monitor these populations. Gossyplure was supplied by another county. With regard to cotton, 200,000 mu received four or five treatments of insecticide per year. Chemicals used on cotton against pink bollworm, Heliothis, aphids, and spider mites included Rogor, Demeton, Parathion, and TDN (= tetradifon for mites).

The station had demonstration charts on: (1) Rice pests (insects and diseases) of the county (see Appendix 11); (2) production and application of antibiotics; (3) control of overwintering rice stemborers (hand removal of cut stalks); (4) protection of spiders in the rice paddies (small straw tents were used to collect and transfer spiders to fields where they were needed for use against planthoppers in rice; the spiders handled in this manner included Lycosa [=Pardosa] pseudoannulata, Dyschiriognatha quadrimaculata, Erigonidium [=Tmeticus] graminicolum, Clubiona japonicola, and Tetragnatha shikokiana); (5) use of ducks (for control of rice insect pests); and (6) research data involving Bacillus thuringiensis preparation 7216. (This was effective against leafrollers, Heliothis and cabbageworms; a preparation coded 171 was effective against the yellow stemborer.)

Jinkuan (Chin-k'uan) Antibiotics Production Plant

The plant, located in Changshu County near the town of Changshu, was established in 1976 and put into operation in 1977. It had 50 workers and staff members and a production capacity of 500 tons per year of the Streptomyces hygroscopicus var. jinggagensis microbial preparation (1 percent active ingredient). Production records had been as follows: 300 tons in 1977, 400 in 1978, and 500 in 1979. The target of this antibiotic production was rice sheath blight (caused by Rhizoctonia solani), a disease of increasing importance in the region because of the increase of double and triple cropping of rice and because of earlier planting dates and greater plant densities. Previously, synthetic organic fungicides were applied widely, but because of concerns about pollution such applications were very limited by 1979.

The strain of S. hygroscopicus var. jinggagensis was selected from PRC soils (taken from a place near the home of the late Chairman Mao) in 1973 by the Shanghai Institute of Agricultural Chemicals. The microbial preparation produced by the plant was intended mainly to meet the needs of the county. Five of the eight counties in Suzhou Region also had a similar plant. In addition, some of the communes produced their own jinggagensis preparation by "indigenous methods." Communes also produced other types of microbial pesticides.

The preparation was applied to the first crop of paddy rice. It had a level of efficacy of 90 percent in controlling sheath blight, if applied twice during the peak period of the disease. The amount of pure active ingredient applied per mu was 5 grams. This was applied at 40 ppm. The effective residual period was 10 days. The material appeared to be harmless to people and animals.

The preparation was made in a two-stage fermentation process. The main fermentation materials were starch, silkworm pupae, and yeast. The production consisted of three steps: (1) Spore preparation, (2) expansion of culture, and (3) fermentation in a large tank. This was followed by filtration, concentration, and "packaging." Step 1 was performed in a laboratory at the plant, but the original isolate was provided from Shanghai. In stage 1 of the formulation process (that is, step 2 above), 700 liters (2 tons) of material were fermented for 24 hours at 40° C. This material was then transferred to a larger fermentor (step 3) and expanded to 17,000 liters (ten tons); fermentation in this tank was for 36 hours at 40° C. The final product was a 30,000-unit solution, bottled in 500 ml and 1000 ml bottles. The pH was 2 to 4; density was 1.6; solid content was 0.369 g/ml; sediment was less than 5 percent; and effective shelf life was 2 years.

Some thought was being given to using this or a similar plant for the production of Bacillus thuringiensis for use against cotton insects.

Zhi Dang Commune, Changshu County

The 10^{th} Production Team of the 1^{st} Brigade of this commune consisted of 49 families, 189 people, of which 100 were workers. They farmed 20 hectares of rice and other grains (wheat, barley, and "hulless barley"), under a multiple-cropping system. In 1978, 19.26 hectares of rice produced 7.91 tons per hectare; 13 hectares of the three other grains produced an average of 3.76

tons per hectare. The average yield of rice and grains combined was 11.67 tons/ha, and annual total yield was 201 tons. Rape was planted on 1.8 hectares which produced 2.47 tons of seed per hectare. In 1979, production of the three "grains" was 4.79 tons per hectare (12.5 ha) and of rape seed, 1.72 tons per hectare (1.8 ha); no figures were given for rice, since harvesting was not completed by July.

The production team began to experiment with the use of ducks to control planthoppers in rice in 1978, when the fourth generation planthopper population reached outbreak proportions. They used 500 ducks on four hectares of rice, using no insecticides, and obtained good control of the planthoppers. In terms of insecticides not applied, 60 yuan per hectare were saved in 1978. (One yuan = $0.66 in 1979.)

In 1979, two "crops" of ducks were being used. The first, 500 ducklings, was begun June 20, to control rice planthoppers (Delphacodes and Sogatella spp.) and rice leafhoppers (Nephotettix spp.). The second, 300 ducklings, was planned to begin in August, to help control brown planthoppers (Nilaparvata lugens). The ducks were being utilized on eight hectares; since June 20, no chemicals had been required, and the rice seedlings looked good in July.

The ducklings were herded into the rice paddies for 1 hour in the morning and 1 hour in the afternoon. At first, they were given no food in the morning, but were given some in the evening; as they grew, they were also fed about "a third of a meal" in the morning. If the ducklings were too hungry when herded into the paddies, their consequently aggressive feeding behavior injured the rice seedlings. Food consisted of bran mixed with a small amount of "husks." The ducks grew 1.25 kg in 3 months, during which time they were each fed a total of 2.5 kg of food.

Benefits of using ducks for hopper control were: (1) Reduced pollution in the paddies and better health for workers; (2) money saved due to elimination of insecticidal treatment (240 yuan saved in 1978 on the four experimental hectares); (3) pest populations were reduced, while helping plant growth (by loosening the soil) and weeds were also reduced [primarily duckweed?], with a savings of labor; (4) increased yield (estimated to be 15 percent, or 1.5 tons/ha in 1978); (5) each duck could be sold for cash for the commune or provided meat and thus better nutrition for the people. In 1978, each duck was sold (or was considered worth) 1 yuan (net); thus, the team netted 500 yuan in 1978 for the ducks. Thus, in 1978, total benefits were 740 yuan, 15 percent yield increase, and the intrinsic factors of reduced pollution, reduced labor, and better nutrition.

In this commune, 35,000 ducks were being used in 1979, and 500,000 were being used throughout Changshu County.

An examination of the stomach contents of two dissected ducklings showed a total of about 30 leafhoppers and planthoppers, plus some dipterous larvae (stratiomyids and syrphids -- Eristalis), and some duckweed.

Bai Mao Commune, Changshu County

The microbiological plant of this commune was established in 1970. It used locally produced materials to produce solid microbial preparations for direct application to soil on the commune, an exclusively solid material

fermentation process. Though produced mainly for local use, about 10,000 kg of material were prepared each year for other communes or peasants who had their own special isolates and wanted cultures added to the soil.

These microbial preparations included the following coded preparations: 920, 5406, 7216, and 702. The farmers of the commune were reportedly very pleased with the quality of the materials produced by the plant. (See notes for July 21 for more comments on these preparations.)

The "920" preparation was used as a growth stimulant for rice. It was not known to control diseases or insects. The following mixture was applied as a top dressing for rice: 20 ppm "920," 60 ppm "702," and 2 percent superphosphate. This caused a yield increase of 25-30 kg/mu of rice; and this exceeded the yield increase from a single application of fertilizer alone.

Preparation "5406" was a "microbial or bacterial fertilizer" which was applied as a seed dressing for wheat and as a "base fertilizer" for rape, wheat, and rice seedlings. This preparation caused each wheat plant to produce an additional root and increased the weight of the wheat root system by 1 ton per mu. A single application of this microbial fertilizer increased wheat yields by 20 kg/mu and advanced maturation by 2 or 3 days. The yield response of a single application of 150 kg of microbial fertilizer was equivalent to the yield response of 35 to 40 kg of superphosphate fertilizer. Hence, the use of the very expensive superphosphate could be replaced with the microbial fertilizer.

Preparation "7216" (Bacillus thuringiensis) was applied to vegetables and fruit trees to control armyworms and leafrollers and to wheat against armyworms. The efficacy "was as high as 80 percent."

Preparation "702" was a nucleotide or nucleotide hydrolyzate obtained from an undefined microbial product.

A Streptomyces hygroscopicus jinggagensis preparation was also produced for use to control sheath blight of rice. When properly timed, the applications had an efficacy of 80 percent. Beauveria bassiana was also being produced on an experimental basis.

During the past 5 years the plant had produced: (1) 3200 kg of Preparation 920 which was sufficient for 16,000 mu treatments; (2) 83,500 bottles (about 500 ml in size) of Preparation 5406 (0.2 kg/bottle) which was sufficient for 14,600 mu-treatments (this was applied directly to the soil and as a seed-coating); (3) 25,250 kg of the S. h. jinggagensis preparation which was sufficient for 47,400 mu-treatments; (4) 2500 kg of Preparation 7216 (B.t.) which was sufficient for 850 mu treatments (most of which was for vegetables and fruit trees, for control of armyworms and leafrollers; some was applied to wheat for armyworm control); (5) 7800 bottles of nitrogen-fixing bacteria (Rhizobium) from vetch which was sufficient for 11,400 mu treatments of vetch (Suzhou Region grew about 1,500,000 mu of vetch per year for green manure); and (6) 1600 bottles of compost bacterial fertilizer which was sufficient for 1300 mu-treatments.

The commune purchased only a small proportion of its needs for microbial preparations from the county. Some farmers on the commune or of other communes sent their own materials for fermentation. These fermentation products were returned to the farmers for use on their private plots. The farmers paid for this service. The *Beauveria bassiana* was produced in 500-ml bottles on polished rice. The *B. t.* was similarly produced in 500-ml bottles containing 80 to 110 grams of a mixture of bran and rice hulls. This yielded 75 grams of dry material per bottle.

The plant employed 16 persons. The work load was somewhat seasonal but the plant never shut down. It was basically intended to meet the needs of the 20,000 people of the commune who farmed 40,500 mu. The main crop rotation of the commune was wheat-rice-rape. Cattle and ducks were also produced.

Taicang County Pest Monitoring and Forecasting Station

Taicang County was in a subtropical region, with an average of 233 frost-free days. Several different annual crop rotation systems existed in the county, the two main ones being rice-rice-wheat (or rape or green manure) and cotton-wheat. There were more than 30 plant pests in the county, the main ones being: wheat scab, "wheat worms" [probably armyworms], and aphids on wheat; *Sclerotinia sclerotiorum* and aphids on rape; rice blast, pink, yellow and striped stemborers, leafrollers, and brown planthopper on rice; and *Heliothis*, pink bollworm, aphids and spider mites on cotton. Before 1949, damage by insects and diseases was about 40 percent of potential yield. With the introduction of integrated pest management (IPM) during the 1970's it was believed that yield losses were often no more than 2 to 3 percent and that overall effectiveness of IPM was greater than 90 percent. Biological control had played a major role in IPM.

The monitoring and forecasting station was established in 1959, and occupied an area of 15 hectares. It employed six scientists and two skilled workers. For monitoring pests, spore traps, light traps, sex attractant traps, and color traps were used. Direct field observations were made on all pests. The Station produced both "medium length" forecasts (15 days in advance) and long-term forecasts of 15 to 40 days in advance. Both single and multiple factors figured prominently in forecasts.

Pest monitoring and related research activities focused on the following: (1) Brown planthopper with special studies on migration and development rates in the field (in conjunction with monitoring studies, research was conducted on methods of control and IPM systems); (2) striped rice stemborer; (3) paddy rice diseases (research was conducted on methods of preventing these diseases); (4) sex attractant traps for pink bollworm; and (5) dynamics of natural enemies with associated research on their use in integrated control.

The station promoted prevention as the fundamental strategy of crop protection and IPM was supplementary. This had resulted in maintaining the "ecological balance" and had minimized environmental pollution. Also, the station "popularized the reasonable utilization of chemicals."

Concerning integrated control measures other than biological, attention was given in three areas: (1) Host plant resistance (rice varieties resistant to blast and the brown planthopper; wheat varieties resistant to wheat stem rust); (2) soil moisture adjustment or management to help prevent sheath blight of rice (this apparently meant the practice of draining the paddy on schedule or as early as possible to allow drying of the lower canopy); and (3) rotation (dry-wet) to help prevent rice sheath blight and rice blast, *Fusarium* wilt of cotton, and *Sclerotinia* of rape.

With regard to biological control, *S. h. jinggagensis* preparation was used to control diseases, ducks were used to control leafrollers, planthoppers and weeds, and *Dibrachys* was used to control the pink bollworm. Various (unspecified) measures were used to conserve coccinellids and natural enemies were used to control aphids on seedling stages of cotton (these concerned conservation rather than augmentation practices).

The use of chemicals in integrated control in the county was changed in the following manners: (1) More selective insecticides [for example, MTMC (Tsumacide-C_3-metacrate)] were used in place of broad-spectrum materials (such as BHC-MTMC) to control brown planthoppers; (2) insecticidal dusts and sprays had been deemphasized and soil incorporated granular systemic insecticides were being recommended; (3) frequency of application had been reduced; (4) applications were better timed; that is, to avoid harm to beneficial insects such as *Dibrachys* and coccinellids; and (5) applications were more selective; that is, applied on a "spot" basis rather than on a whole field basis.

Spiders were used to control the brown planthopper, *Nilaparvata lugens*, a major pest of rice in the area. *Heliothis* was controlled by means of insecticides, light traps to catch females before oviposition occured, and traps baited with a mixture of poplar and willow branches. (The traps were also used for monitoring.)

SUZHOU REGION, JIANGSU PROVINCE, JULY 19

On Thursday, July 19, the delegation visited the Dong Ting Commune of Wu County and recorded the following notes.

Dong Ting Commune, Wu County, Suzhou Region

The Dong Ting commune was located near Tai Hu (Lake Tai). Chestnut trees in the commune had evidence of chestnut blight. The commune had three of the four varieties of chestnut in Suzhou Region. Only one or two trees were really large. Several others were young shoots, 3 to 4 m high, from old trunks presumably destroyed by the blight. Every tree had evidence of surgery, presumably branches removed when they were killed. One or two cankers were 25 to 30 cm vertically and 15 to 20 cm across, but most were smaller. (Some of the cankers were collected by the delegation; see Appendix 2.) The chestnut gall wasp, *Dryocosmus kuriphilus*, was said to be a serious pest there.

The commune grew many orchard crops, including several varieties of pear, peach, and citrus. The delegation noted one cast skin of a psyllid on pear and a lepidopterous twig-borer (*Anarsia*?) was common on the peach trees examined.

SHANGHAI, JULY 20

On Friday, July 20, the delegation visited the Biology Department of Fudan University and the Shanghai Institute of Biochemistry of the Chinese Academy of Sciences. The following are notes on these visits.

Fudan University, Biology Department

The Department of Biology of Fudan University had nine groups or "specialities": zoology (including entomology), pathology, botany, animal physiology, plant physiology, genetics, biochemistry, microbiology and biophysics; a Genetic Research Institute and an Anthropology Laboratory. A Division of Virology was to be established.

The department was studying the use of phytoseiid mites for control of the citrus red mite (Panonychus citri), the major pest of citrus in China. Spider mites were a major pest of citrus now because of large scale use of insecticides for citrus scales; they were not a problem 20 years ago. Insecticides were now applied on citrus 10 to 20 times a year, these chemicals being TDN (tetradifon) and DDVP at one part per 1000 to 2000 parts of water. Forty kilograms of this mixture were applied per tree per application.

Phytoseiulus persimilis introduced from Chile was released on citrus in the Suzhou Region against the citrus red mite, but it had failed to become established, possibly due to unacceptable climatic conditions. Two native Chinese species (originally collected in Shanghai Municipality), Amblyseius [=Typhlodromips] tsugawai and A. deleoni [=herbicolus], had been cultured and released experimentally in the Shanghai area (on cotton -- see below -- and probably also on citrus). The Amblyseius were being laboratory-cultured on pumpkin pollen, but also had to be fed spider mites in order to reproduce. Earlier in 1979, the zoology group experimented with the use of these two species against spider mites on cotton. They were able to reduce the number of treatments of pesticide (DDVP) from about 10 times to 2 times per year. The predatory mites were returned to the plants about 1 week after insecticide treatment. Information on the size of the experimental area was not obtained. This work was soon to be published.

The zoology group was also conducting a survey of mites, particularly of the Oribatei, in the Shanghai Municipality.

Major citrus production in China was in Jiangsu, Fujian, Guangdong and Zhejiang Provinces, but, in general, citrus was grown in all provinces south of the Chang Jiang (Yangtze River).

In insect pathology, work on both nuclear polyhedrosis virus (NPV) and granulosis virus (GV) of Heliothis armigera was being conducted, some of which had been published. Heliothis armigera was being cultured on artificial diet there. The culture was in its eighth generation; the ingredients of the diet medium used had been published (Le et al., 1978).

Plant viruses in the region included barley yellow mosaic, vectored by the fungus Polymyxa graminis. The virus particles measured 600x13 nm. The disease was first discovered on a farm in the Shanghai area. Interestingly, a resistant line had also been selected from the field where the disease occurred, which helped to confirm that the peasant wheats were a real genetic mixture.

An earlier report from the Microbiology Institute in Beijing that soilborne mosaic was also on wheat in China was confirmed by the department. Wheat spindle-streak virus was also present. One control used in the Shanghai area was to plant wheat late; for example, in December.

Other viruses were the rice yellow stunt virus (bullet-shaped, rhabdovirus), the barley stripe mosaic virus (BSMV, particles averaged 100 nm, but ranged widely on both sides of this mean; BSMV in China occurred as three serotypes), the soybean mosaic virus (seedborne; virus particle was a flexuous rod, 750 nm), and the tobacco (TMV) and turnip mosaic virus (both of which occurred in Chinese cabbage).

The turnip mosaic was a nonpersistent virus vectored mechanically by aphids. The TMV, on the other hand, entered the roots at transplanting when wounds were abundant. Infected cabbage remained small and unthrifty, so they were fed to pigs. The virus was unharmed at temperatures to 96° C and apparently cycled back into the soil via the pig manure in compost, or remained in the soil in the infected root remnants.

Shanghai Institute of Biochemistry, CAS

The Shanghai Institute of Biochemistry was separated from the Institute of Physiology in 1958. There were 300 scientists and technicians, including 31 senior professors in the eight divisions of the institute, in addition to the staff and workers of the institute's two factories, for a total institute staff of 570. The staff of the two factories was soon to be doubled.

The two factories were for production of: (1) Biochemicals such as nucleotides, enzymes, and others; and (2) scientific instrumentation required by the institute, as well as for providing equipment maintenance. The work of the biochemical factory originated as a result of the insulin-production program of the years 1958 to 1965. For this program, the institute had had to produce every amino acid needed for production of insulin, which the institute had synthesized, and had resolved both the D- and L-forms. The factory was currently manufacturing five different biochemicals.

The eight divisions of the institute and their major thrusts were as follows.

1. Protein and Peptide Synthesis Division. This division was engaged in the insulin work. They had hoped to synthesize the protein of tobacco mosaic virus (TMV). It had 158 amino acid residues. By conventional synthetic approaches the polypeptide chain could not be made because it became insoluble when only 40-50 amino acids were linked together. (Dr. R. B. Merrifield of Rockefeller University used a solid support system to synthesize an RNA molecule of 124 units. He had discouraged this approach because it was very difficult to separate out molecules with "misses" of one or two amino acids.)

To overcome these problems the method of fragment condensation had been developed. Segments of seven to eight amino acids were first synthesized and then snapped together in the proper sequence. In this case molecules with misses of seven to eight acid residues were readily separated out. The method worked very well with glucagon (28 amino acids). The institute was then to attempt to synthesize the long chain of the insulin molecule (51 amino acids)

as well as polypeptides from snake venom (60-70 amino acids). If success was attained with these polypeptides, then the institute would attempt to synthesize the TMV protein.

The institute was experienced in working with biologically active peptides (for example, hormones). For example, in aquaculture, fish (carp) fry were shipped from the upper Chang Jiang (Yangtze River) because females would not spawn in the stagnant waters around Shanghai. Flowing water was needed to stimulate the hypothalmus. Pituitary extracts when injected induced spawning readily, but this was a very expensive method. Therefore, the institute decided to make the lutein releasing hormone (LRH), which had 10 amino acids. The synthetic was currently used extensively in aquaculture as well as for inducing fecundity in barren women who badly wanted a child.

The institute was studying the structure-activity relationships of portions of the insulin molecule. Proteolytic enzymes were used to cleave up to eight amino acid residues from the C-terminal of the beta chain. Such sequences were then replaced with various synthetic concoctions which might involve entirely different amino acids or the D-form in place of the L-form.

2. Nucleic Acids Synthesis Division. Organic and enzymatic synthesis methods were used. The staff was working on a transfer RNA with 77 nucleotides, about midway in the program of synthesizing short fragments and of subsequently snapping them together enzymatically. They felt that they were far behind in research on sequencing nucleic acids in polymers.

3. Enzymology Division. This division had worked on solid phase syntheses using immobilized enzymes such as phosphodiesterase and glucose isomerase. The penicillin ring without side chains had been produced in this manner. Enzymes immobilized on a solid substrate remained active for up to 1 year. They were useful in factories because very little organic solvent was needed. Efforts were underway to immobilize entire cells or at least major cell organelles on column substrates. Such work was being conducted with biomembranes with emphasis on the oxidation-reduction enzymes of the mitochondrial membrane. This membrane was easy to peel off and to reconstitute. The staff felt that they lagged behind in lipid and sugar biochemistry. They were conducting research on the use of nucleic acid hydrolysates for raising crop yields.

4. Cancer Biochemistry Division. The institute developed a technique for the early diagnosis of liver cancer (heptoma), the major cancer in China. This was a big problem in Shanghai. The cancer progressed very rapidly. When liver cancer developed, the gene that determined the synthesis of alpha fetal protein became derepressed. (In normal livers this gene was repressed at birth and healthy people lacked this protein.) The institute developed a simple procedure for detecting alpha fetal protein. They tagged an enzyme with a labeled antibody. The procedure was so simple that it could be used by the "barefoot" doctors of the communes. Several million people had been screened with this procedure. After 500,000 had been screened, the data were examined for correlations. Weak correlations existed between carcinoma and (1) hepatitis, (2) molybdenum deficient diets, (3) water quality (pollutants), and (4) consumption of fermented foods. The institute was probing into these correlations and was also planning to consider how the gene for alpha fetal protein was derepressed. Lung cancer was also being studied. Research of this division was to be expanded.

5. Steroid Hormone Regulation Division. This was a new division, one function of which was to study receptors of steroid hormones in the blood stream. The mode of action of estrogen was receiving attention, especially the effect of the hormone on protein synthesis.

6. Virology Division (a "heterogeneous group"). This division was studying diseases of cereal crops (wheat, rice, corn), fruit trees (for example, citrus, jujube), tomatoes, green vegetables, and trees of economic importance (for example, mulberry). One institute scientist was on temporary duty in Hebei Province to conduct research using radio immunoassay (RIA) to determine whether certain insects and plants harbor viruses. The division was attempting to (1) ascertain the nature of viruses, and (2) develop and use serological methods of diagnosis. They had discovered many new viruses and mycoplasma-like organisms (MLO). Colleagues in the far northwest of the People's Republic of China collected diseased plants and insect vectors and sent them to the institute for study.

One group worked on insect viruses, including the cytoplasmic polyhedrosis virus (CPV) of the silkworm, a double-stranded RNA, as discussed below.

Another thrust of this "heterogeneous group" involved the hybridization of remote species such as sorghum X rice and rice X maize. Some research institute in the People's Republic of China had made maize-rice crosses. Cytogenetically the hybrid looked like rice and the chromosomal behavior was normal; it was a stable cross that bred true. It looked like rice but tasted like corn. Apparently some maize chromosome fragments had become inserted into the rice chromosomes. This was borne out by isozyme studies. There was a need to know <u>why</u> such crosses were possible.

This group also studied the biologically active principles in medicinal herbs. A protein had been isolated which caused the early arrest of pregnancy (after the zygote had been implanted into the uterus). This was a crystalline protein which dissociated in solution into four chains. The herb had been used for birth control since ancient times. Sequence work and X-ray analysis had been accomplished.

The group also worked on the isolation of trypsin inhibitor protein from mung bean.

7. Genetic Engineering Division. This was a new division, studying molecular genetics. It was preparing plasmids and restriction enzymes. Its program was not yet well defined. (P-3 level laboratories were the highest safety goals required in the People's Republic of China.)

8. Instrumentation Division. Equipment, such as fraction collectors, high voltage sources, ultracentrifuges, and others, was designed and manufactured by this division; such equipment was repaired for the institute. During the 10-year Cultural Revolution, the only instrument purchased by the institute was a Japanese-made Spectropolarimeter JASCO J-20; and seven major instruments were removed from the institute. The institute manufactured its own amino acid analyzer and ultracentrifuge (40,000 RPM). The performance of the ultracentrifuge was limited by lack of a really appropriate electrical motor. The government bureau responsible for manufacture of machinery and instruments had given low priority to manufacturing items that had a "market"

in the People's Republic of China of less than several hundred thousand. Therefore, each institute had a major machine shop or laboratory to meet its own needs.

The institute also had some work on a protein neurotoxin (13,000 molecular weight) isolated from the poison of the pit viper Agkistrodon halys. Several species of pit vipers occur in People's Republic of China. They had a very broad geographic distribution. The antivenom was made in Shanghai. Polyacrylamide gel electrophoresis (PAGE) showed that the composition of the poison from a given species varied widely from one geographic location to the next. The neurotoxin was highly potent. In addition, the venom contained 15-30 mg (dry weight) of phospholipase per snake.

Among the numerous research activities of the institute, the work with plant viruses and insect vectors, insect viruses and insect biochemistry was of special significance to PRC scientists.

Plant Viruses and Insect Vectors. Plant pathogen work was organized into three groups: (1) cereal crops, (2) trees, and (3) vegetables.

1. Diseases of Cereal Grains. The rosette stunt virus, which caused goat's beard, was a rhabdovirus. The vector was the small brown planthopper, Laodelphax striatella. The virion was a nucleocapsid tube wrapped in an envelope with numerous projections. There was an additional component on the inside of the nucleocapsid. The virus was in the salivary glands of the planthopper, but without the outer envelope; that is, the infective nucleocapsid was bare in the insect.

The maize streak dwarf virus was also a rhabdovirus. The vector was also L. striatellus. The maize rough dwarf virus was spherical and vectored by L. striatellus. The virus had been found in infected nymphs. Planthoppers were observed to contain both the rhabdovirus of rosette stunt, and the spherical particles of maize rough dwarf virus.

The rice yellow dwarf and rice dwarf virus. The rice yellow dwarf virus was a rhabdovirus that occurred inside the nuclear membrane of the rice cell and was vectored by Nephotettix cincticeps, the green rice leafhopper. The rice dwarf virus was an isohedral particle.

2. Diseases of Trees of Economic Importance. Mulberry common dwarf disease was caused by a mycoplasma-like organism (MLO) which the plant virus group had observed in phloem cells of new shoots. In addition, they found filaments of material which were consistently present in diseased but not healthy tissue, but which had no proven function. The group had shown the existence of MLO in the salivary glands of the vector, the mulberry leafhopper, Hishimonoides sellatiformis. (The MLO could be seen in ultra-thin sections of the salivary glands of the leafhopper.)

MLO had also been found in citrus with the yellow shoot disease, which was vectored by Psylla sp., Chinese jujube (date) with witch's broom, sweet potato with witch's broom, and baronia (an ornamental shrub) with witch's broom. (The vector of witch's broom was unknown; Cicada was suspected.) This was consistent with general knowledge that many of the yellows-type "virus" diseases and all of the witch's broom diseases were turning out to be caused by MLO. What seemed new was the report of the thread-like filaments resembling

virus particles in association with the MLO. In the case of yellow shoot disease, these filaments measured 12x2500 nm. For witch's broom of Chinese jujube and sweet potato, they were only described as rods or thread-like particles but no measurements were given.

3. Diseases of Vegetables. In vegetables, the group was involved in a study of tobacco (TMV) and turnip mosaic in Chinese cabbage, and tomato streak virus.

Immunological techniques were used to detect virus in the insect vectors. The rice dwarf virus was partially purified and from this, antibodies were made from rabbit. A passive hemagglutination test was found to be sensitive for small amounts of virus. A good correlation (86 percent) was obtained between this test and the biological assay, which took too long. For wheat rosette stunt virus (which was vectored by a planthopper) the correlation was 89 percent. The ELISA technique was also used.

Insect viruses. Research was conducted on the cytoplasmic polyhedrosis virus (CPV) of the silkworm. The CPV had been isolated and purified by means of a sephadex column chromatography. Messenger RNA (mRNA)was synthesized *in vitro* and purified in milligram quantities. By means of gel electrophoresis "natural" mRNA (if single stranded) could be resolved into nine bands. Double-stranded mRNA fluoresced differently than single-stranded mRNA. A wheat-cell-free system was employed to use mRNA in *in vitro* protein synthesis. Influenza virus was purified on a sephadex column.

This work also provided information of value in plant virus studies. For example, serological "cross reaction" experiments had been conducted with rice dwarf virus.

The staff had also experimented spraying RNA hydrolyzate on rice seedlings in the nursery, and by this method improved tillering and number of spikes and increased yield by 5 to 8 percent. In particular, the treatment increased root growth and the capacity to absorb fertilizer, a phenomenon the staff demonstrated with ^{32}P. The effect was due to the nucleotides and not increased cytokinins. *Geotrichum candidum* grown in industrial wastes with either sodium hydroxide or hydrochloric acid could serve as an economical source of RNA hydrolyzate in agriculture. [This was one of the microbials being used at Bai Mao Commune in the Suzhou Region (see notes for July 18).]

Insect Biochemistry. Amino acid metabolism was being studied in the silkworm, *Bombyx mori*, and its relative *Philosamia* [=*Samia*] *cynthia ricini*. The concentration of amino acids was very high in insects in comparison to vertebrates. Fibroin biosynthesis was studied in the posterior silk gland of *B. mori*. *Bombyx* fibroin was 42 percent glycine and 30 percent alanine. By contrast, fibroin of *Philosamia* had a composition of more than 50 percent alanine and less than 50 percent glycine. Thus, certain enzymes were more active in *Philosamia* than in *Bombyx* and vice-versa.

The staff had also been studying the effect of juvenile hormone and of the hormonal analog Zr-515 on silk biosynthesis in the fifth instar of *B. mori*. (Juvenile hormone analog of silkworm was used at the commune level to increase silk production.) These substances greatly increased glycine and alanine biosynthesis in the posterior silk gland as well as in the fat body. These exogenous substances increased silk production by 10 to 20 percent,

prolonged the fifth instar by 1 day and increased the weight of the cocoon. The increased silk production was shown to be caused by two factors, as follows: (1) by prolonging the fifth instar, there was more time to synthesize silk; and (2) the hormone and hormone analogs accelerated the rates of enzyme-mediated reactions (GOT-ase, in forming alanine and also arginase activity was increased). The urea cycle was absent in the silkworm; arginine was formed in place of urea or uric acid.

Molting hormones were also used in silkworm production. When mulberry leaves were in short supply, the larvae were treated with molting hormone and prematurely induced to pupate and spin cocoons. In this way, starvation was avoided and silk production was assured. (See also notes for visit to the institute of Organic Chemistry, July 21, for more discussion on this subject.)

Nucleic acid hydrolysate was sprayed on field crops to increase yields of rice, and other crops.

SHANGHAI, JULY 21

On Saturday, July 21, the delegation visited a Shanghai Microbiological Plant, the Shanghai Institute of Entomology, and the Shanghai Institute of Organic Chemistry. Both of the institutes were affiliated with the Chinese Academy of Sciences. The delegation also had a discussion with PRC scientists on plant pathogen research and weed control. The following are notes of these visits and discussions.

Shanghai Microbiological Plant for Production of *Bacillus thuringiensis*

This microbiological factory produced *Bacillus thuringiensis* (*B.t.*) for the Shanghai area. The product was marketed under a name that translated as "pyralid borer killer" (so named because of its origin from the yellow rice stemborer). The plant had a staff of 28 people, and produced 180 metric tons of *B. t.* per year, which was enough to service Shanghai Municipality. In 1980, an output of 400 tons was planned. It began production in 1970.

The *B. t.* preparation was applied mainly on cabbages and shade trees in the area at a rate of 100 g/mu ($1x10^{10}$ spores/g) in a solution of 1 part *B. t.* to 1000 parts water. [Major cabbage pests in the area were the cabbage aphid (*Brevicoryne brassicae*), diamondback moth (*Plutella xylostella*), cabbage butterfly (*Pieris rapae*), and the cabbage moth (*Mamestra brassicae*); major shade tree pests were not determined.] The *B. t.* preparation was not used on cotton in the Shanghai area. Instead, cotton was treated once with Rogor against aphids followed by four carbaryl (Sevin) applications against the pink bollworm.

The original culture (serological type = "*galleriae*") was isolated from the yellow rice stemborer, *Tryporyza incertulas*, collected in the Shanghai Municipality. It was effective on many lepidopterous pests, but was not useful on stemborers.

The effectiveness of the product was monitored. Each large batch was bioassayed 24 hours after production using *Pieris rapae* larvae; the LD_{90} at 28° C was $0.2x10^8$ spores/ml.

Production was achieved in two phases. A starter culture was fermented for eight hours at 35° C (250 kg of spores) in 130 liters of broth with the addition of air. This beer was then pumped into a 10,000-liter tank and the broth was increased to 8000 liters. Again fermentation was achieved at 35° C with the addition of air. This phase required 19 hours. The medium consisted of a corn paste. Air was bubbled through the medium to prevent anaerobiosis. The final beer was transferred into a storage tank. From the storage tank the beer was pumped into a segmented "pressing apparatus." Each segment had verticle steel ribs that were covered with cloth. The cloth filtered out the spores and the liquid was drained off through a stopcock. This B. t. preparation was 40 percent water. The preparation on the cloth was then placed on 100x100x2.5 cm pans and placed for drying in a cabinet 2 m high with shelves spaced at about 7 cm intervals. There were five such cabinets.

Shanghai Institute of Entomology, CAS

The Institute was formerly a Shanghai station of the Institute of Entomology in Beijing which was now the Beijing Institute of Zoology, Academia Sinica (CAS). Since 1959, it had been redesignated first as Shanghai Institute of Applied Entomology, and later as East China Institute of Entomology, and was renamed as Shanghai Institute of Entomology, Academia Sinica, in 1977.

The research work of the institute had been on the control of agricultural pests, mosquitoes and termites in eastern China, and on the taxonomy of some insect groups throughout the country. As an institute in Academia Sinica, attention had been paid to promoting research on pest control from the viewpoint of environmental protection. New methods and approaches had been explored.

The institute had a total staff of 208 of which 70 percent were research workers distributed in five laboratories.

The Insect Toxicology Laboratory was conducting research on the genetic and insecticidal control of mosquitoes. A strain of Culex pipiens pallens with 200-fold resistance to Dipterex was selected after 82 generations of pressure. This strain showed cross-resistance to DDVP, Phoxim (8X), sumithion (6X), malathion (9X), Baytex (66X), Abate (11X), and dimethoate (2X). However, the strain was more susceptible than the normal strain to pyrethroids (permethrin and tetramethrin and natural pyrethrins). At least two major genes determined the resistance. Curiously this strain had a very large increase in carboxyesterase (yet resistance to malathion (9X) was not profound). This work was in press. (Culex pipiens pallens was stated to be the most important mosquito in China and Dipterex was stated to be the insecticide most used for mosquitoes in China.)

Studies were also conducted on Anopheles sinensis. This was the most dangerous malaria vector in China. In 1961 A. sinensis was still susceptible to the chlorinated hydrocarbons, but by 1973 gamma-BHC resistance had developed inadvertently as a result of the use of this insecticide against the rice stemborers. Resistance to gamma-BHC began to diminish in 1977. In 1970 directives had been issued to terminate all use of gamma-BHC; however, this directive was implemented on a patchwork basis and several years were required for full implementation. Continuing use of P,P-DDT maintained DDT resistance in A. sinensis in some areas.

Research was underway to develop translocation strains in _A. sinensis_. The chromosomes were marked as follows: Chromosome I -- larval red eyes; Chromosome II -- larval yellow body; and Chromosome III -- larval black head. Five thousand roentgens were found to induce the maximum number of translocations. One translocation strain (50 percent mortality in heterozygotes) had been established.

The laboratory had shown by polyacrylamide gel electrophoresis (PAGE) that insecticide resistance in mosquitoes was related quantitatively to amounts of carboxyesterase in the mosquito. This enzyme detoxified the insecticide.

The Laboratory of Experimental Technology, in cooperation with the Insect Physiology Laboratory, had designed an antenna chamber to measure sensory response to pheromones. The work was based on that of W. Roelofs of the New York Agricultural Experiment Station in the United States. The Chinese metal antenna chamber apparently provided better shielding than the screen cage used by Dr. Roelofs. The components of a sex pheromone of the tea geometrid, _Boarmia_ [=_Ectropis_] _obliqua hypulina_, had been identified using this technique. This same technique was being used to study sensory adaptation to gossyplure and hexalure by the pink bollworm.

The ovipositors were clipped off the abdomens of tea geometrid females, washed with dichloromethane and separated by gas liquid chromatography. Three fractions 8, 13, and 17, showed electroantennogram (EAG) activity. None of these fractions when used alone would attract moths but some caused wing vibration. Fractions 13 and 17 when mixed together attracted males in the field at night. The greatest response of pink bollworm antennae to gossyplure occurred when the isomers were in a ratio of 1:1. Also, hexalure and (_Z_)-7-dodecenyl acetate induced a moderate EAG response. Many other compounds induced a weak response. In order to evoke a response the molecule needed a (_Z_)-7 configuration. The 16-carbon acetate was quite attractive.

Active extracts had been prepared for _Tryporyza incertulas_, and research on kairomones had recently been initiated by the institute.

The Laboratory of Insect Taxonomy and Ecology was conducting a field study of cotton pests with the following objectives: (1) Identify the natural enemies; (2) study the relationship of the natural enemies to the host population (field ecology); and (3) evaluate the effect of the various chemical control programs on this food chain. The studies were conducted at She Shen Peoples' Commune 40 km from Shanghai city. Twenty pest species had been found, three being most important: the cotton aphid, _Aphis gossypii_ (in the early and late crop "season"); the pink bollworm, _Pectinophora gossypiella_ (in the mid-crop "season"); and the cotton red spider, _Tetranychus urticae_. Other cotton pests included _Ostrinia_, armyworms (_Spodoptera_), _Lygus lucorum_, and _Heliothis_; the latter was said to be only occasionally important in this area (there was an outbreak in 1970) because the soil was too wet for pupation; it was more of a problem further north.

Thirty species of natural enemies of the 20 pest species had been found, including the following predators of aphids, thrips, whiteflies, pink bollworm eggs and small larvae: Coccinellidae -- _Stethorus punctillum_, _Scymnus_ (_Pullus_) _kawamurai_, _S._ (_P._) _sodalis_, _S._ (_Neopullus_) _hoffmanni_, _Nephus ryuguus_, _Propylaea japonica_, _Harmonia axyridis_ and _Coelophora saucia_;

Chrysopidae--*Chrysopa septempunctata* and *C. sinica*; and Anthocoridae--*Orius minutus* and *O.* sp. The parasite complex included species of Ichneumonidae (two species, only one occurring in Shanghai), Pteromalidae, Braconidae, and other families (including *Pristomerus*, *Chelonus*, *Dibrachys* and others). The four main cotton aphid parasite species were given as *Trioxys* (*Binodoxys*) *communis*, *T.* (*B.*) *rietscheli*, *Lipolexis gracilis* and *Aphidius gifuensis*; there were three other aphelinid parasites. Hyperparasitism was about 90 percent: Species of Figitidae (two species), Ceraphronidae, Encyrtidae, and Microgasteridae were involved. Larval parasites of the pink bollworm were *Bracon isomera*, *B. nigrorufum* and *Chelonus pectinophorae*. This information was soon to be published. The group also studied the use of *Tetrastichus*, apparently originally from Hainan Island, against the yellow rice stemborer.

The insect collection of the Insect Taxonomy and Ecology Laboratory had about 400,000 specimens (about 4000 identified species), mainly from the South China area, although explorations had been made throughout China by institute taxonomists. The collection was begun over 100 years ago, and the same type of insect cabinets were used as in the Beijing collection. Many Chinese entomologists came to study the collections, and the taxonomists were called upon to make identifications in their areas of study. There were large collections of Lepidoptera, Cicadidae, and in some other areas, but not a large collection of parasitic Hymenoptera. There were about 20 boxes of Coccinellidae, but very few identified species. The delegation noted *Rodolia cardinalis* specimens collected in Jiangsu and Zhejiang Provinces in 1958, and at Guangzhou in 1959. It was obvious that *R. cardinalis* was widely established in southern China.

Eurygaster integriceps, called the wheat turtle bug, occurred in the People's Republic of China south of the Chang Jiang (Yangtze River). According to laboratory taxonomists, *Ostrinia nubilalis* occurred in north China, *O. furnacalis* in the south, with intermediate forms in between; seven species of *Ostrinia* occurred in the Shanghai area.

The Insect Physiology Laboratory had conducted a study of endocrine control of mosquitoes (use of juvenile hormone against *Culex pipiens pallens*). - ecdysone on the development of mosquito ovaries was tested. When ecdysone was injected into unfed female mosquitoes (5 to 10 g/female), formulation of the protein necessary for vitellogenesis was induced. The staff had then extracted the ovaries (of fed and unfed females) and determined the presence of yolk protein using electrophoretic techniques (two major bands -- glycoprotein). The crude yolk protein could now be purified. The next step was to identify the amino acid content of the protein and determine its molecular weight. (The -ecdysone could be detected at a picogram level.)

The yellow rice stemborer, *Tryporyza incertulas*, was also studied. It was monophagous; one larva completed development on a single plant. It was being cultured on artificial diet in order to study its nutritional requirements. Five generations had been reared on the diet, but only 35 to 45 percent pupation occurred, and five or six molts occurred (versus four in nature), indicating that the diet was not yet satisfactory. This work had been published (RGIR, 1975a).

The Insect Virology Laboratory focused its work on insect virus pathogens, their pathological and pathogenic mechanisms, and on insect tissue culture. The NPV of mulberry tussock moth, Euproctis similis, studied in this laboratory, had been accepted as an effective measure against this pest in sericulture in the Provinces of Jiangsu and Zhejiang. The virus of the tung-oil-tree geometrid, Buzura suppressaria, was also studied.

Shanghai Institute of Organic Chemistry, CAS

The Shanghai Institute of Organic Chemistry, Academia Sinica, was established in 1950, with 30 to 40 members. In 1979, it had a staff of 1300, including 500 workers in an attached pilot plant (whose purpose was to scale-up the synthesis of chemicals developed at the institute and to produce chemicals needed by the institute), 600 research workers (including 35 associate professors), and workers in glass blowing and instrumentation workshops.

The institute was engaged in three major areas of study (in addition to some work with liquid crystals and instrumentation and glasswork), as follows.

1. "Natural" Organic Chemistry. This included study of biologically active natural products, including insect hormones and pheromones, chemicals involved in photosynthesis, steroids, prostaglandins, and chemicals in traditional medicines (such as herbs), and so on. This involved identification and synthesis of natural products. Work on biopolymers included polypeptide synthesis research (for example, insulin), and determination of structures of polypeptides and proteins. Some of these were isolated from traditional medicines, such as trichothatin which was isolated from cucurbatacin and which had a molecular weight of 24,000. Work was proceeding on nucleic acid synthesis and on studies on single cell-protein obtained by fermenting petroleum. The institute was not involved in DNA transformation.

2. Elemental Organic Chemistry. This included research on organometallic compounds and fluoro-organic compounds. The latter involved studies on teflon, surface active agents, fire retardants and extinguishers. Phosphorus-metallic compounds were studied in order to extract heavy metals (cobalt, copper and nickle) and rare earths from water (hydrometallurgy). A thrust was underway on boron chemistry. Nitrogen fixation was being studied. Metal-containing enzymes were studied as well as "homogeneous base catalysis." Arsenicals were being synthesized and studied for use in the Witich reaction for the creation of methylene bonds.

3. Physical Organic Chemistry. This included research on the mechanisms of organic reactions, sorbent effects, use of computers in calculating reaction rates and products, and liquid crystal chemistry.

The institute produced much of its own apparatus such as a high-pressure liquid chromatography unit. No research on antibiotics was conducted in the Laboratory.

The institute's work with insect hormones and pheromones was initiated in 1963 to support agriculture; studies were in the following three areas.

1. Studies on application of juvenile hormone analogs (JH) and molting hormones (MH) to improve silk production of Bombyx mori. The work had begun with the work of Dr. M. Beroza, of the USDA, Beltsville, Maryland, on his JH analog, JH-25. This compound increased the size of B. mori cocoons, increasing silk production by 10 to 15 percent. Forty milligrams was adequate to treat 2000 larvae. However, the sericulture experts concluded that JH-25 had a major shortcoming in that it lengthened the duration of the final instar larva of B. mori thus requiring that more food be supplied to the larvae. Consequently, an effort was made to find natural sources (phytoecdysones) of molting hormones in order to shorten the fifth instar. The plant Ajuga decumbens [or nipponensis?] was found to contain 0.1 percent steroids including: (1) β-ecdysone, (2) ajugasterone A, (3) stachysterone (had a furan ring), and (4) an unknown steroid. Feeding on β-ecdysone and ajugasterone extract shortened the fifth instar by 12 to 18 hours. Since the plant was very abundant and since extraction was simple, no synthesis was required. These materials were sprayed on the leaves and were eaten by the larvae. Thus, when mulberry leaves were in short supply, MH was used; and when there was an excess of mulberry, JH was used. Another plant, Cyanotis arachnoidea, had an overall steroid content of 1.1 percent and a content of 2.9 percent in the roots. This herb was common in Hunan Province. The steroid was mainly β-ecdysone with a minor amount of the acetate derivative. The institute was also attempting to develop precosenes and other anti-juvenile hormones for use in sericulture and for the control of rice pests. It was also working on the structural elucidation of the JH of Bombyx mori. This was a cooperative effort involving the Shanghai Institute of Entomology and the Beijing Institute of Zoology.

2. Confusion technique for pink bollworm (in cooperation with Shanghai Institute of Entomology). The pheromone gossyplure (800 ug) in hollow polyethylene strands (10 cm long) was used to trap moths, by placement of the strands over water traps. This formulation was produced by mixing gossyplure with polyethylene and heating to the latter's melting point (120° to 140° C). This formulation gave sustained release for about 1 month, and had high activity, equal to five to ten females. The pheromone was extracted from female pink bollworm by a simple heat technique, useful for application at the commune and brigade levels. During the past 5 years, nine provinces had been involved in a confusion experiment with gossyplure. The experiments had been performed on 10- to 20-hectare plots of cotton. Both sex attractant traps and black light traps had been used to sample the population. Females captured in light traps were dissected and examined for sperm. The results obtained from black light traps were inconsistent due to introduction of environmental variables, for example, moonlight, rain, and so forth

3. Synthesis of pheromones of storage pests. Pheromones of the following species had been synthesized: the "grain moth" [?= Tinea granella or Sitotroga cerealella], almond moth (Ephestia cautella), and Indian meal moth (Plodia interpunctella). The use of pheromones for storage pests was discouraging; this work might have been terminated.

The institute had also synthesized pheromones for the corn borer (Ostrinia) (but it was not active), the fruit leafroller, Adoxophyes orana, and the "big bag moth," Psychidae (sic) formosicola Strand [=Clania formosicola, teste D. Davis, U.S. National Museum of Natural History, Washington, D.C.].

Notes on Plant Pathogen Research and Weed Control

The Institute of Plant Physiology in Shanghai had worked on N-fixation, particularly that by *Rhodopseudomonas capsulatea*, *Rhodospyrillum nubum*, and *Chromatium* species. The latter was an obligate anaerobe and the other two were facultative anaerobes. All were apparently aquatics. In 1976, this institute had a good program on N-fixation, but by organisms in roots of native trees. By 1979, they also had work on *Klebsiella pneumoniae*.

The list of antibiotics accumulated during the delegation's visits was clarified (see Appendix 15). The preparations 920 and 702 produced and used at the Bai Mao Commune in Suzhou Region were gibberllin and nucleotide, respectively. The *Streptomyces hygroscopicus* var. *jinggagensis* was legitimate--really worked. The "402" (see notes for July 17) was a synthetic produced by the Institute of Organic Chemistry.

Except for some small-scale special uses of antibiotics against, for example, smut of millet and possibly *Phytophthora palmivora* on rubber trees, *Streptomyces hygroscopicus* var. *jinggagensis*, used against sheath blight of rice, was by far the major antibiotic used in China.

Research on weed control in the People's Republic of China. Weeds in the People's Republic of China were known in all crops, but were most serious in rice, barnyard grass being particularly important. Weed science research began at the Shanghai Plant Physiology Institute in 1962 was halted in 1978 because it was not considered "basic" enough to fit into the institute's recent realignment along basic research lines. The work had been on (1) biological characteristics of weeds; and (2) herbicide use patterns in rice, cotton, and wheat.

An enormous amount of labor was involved in hoeing, hand-weeding, and cultivating with draft animals, but in the heavily populated areas, no change in current practices would be accepted if it resulted in even the slightest decrease in yield. As the People's Republic of China apparently lacked the wherewithal to import large quantities of herbicides, traditional methods were tolerated. State farms, often underpopulated with young people and demobilized soldiers, would probably eagerly adopt practices that resulted in greater efficiency in the use of human labor.

The Institute of Botany in Beijing was said to have had a weed research group that might still be active. Also, the Farm Chemicals Research Center at Nankai University, Tianjin (Tientsin), had a weed science group. In addition, all "local" agricultural academies had applied weed research. The People's Republic of China apparently did not have any research involving mycoherbicides; neither did it have a weed science society.

SHANGHAI MUNICIPALITY, JULY 22

On Sunday, July 22, the delegation visited the Shanghai Botanical Garden and the Bei Qiao Commune. The following are notes on these visits.

Shanghai Botanical Garden

The botanical garden was established in 1954 as a tree breeding center. In 1974 it became a botanical garden. A staff of 400 scientists and workers conducted research on plants and manned the displays. The gardens occupied 70 hectares. Some plants were 200 years old. The garden included a museum on the bonsai method. This method was developed in China 1300 years ago during the T'ang Dynasty. Bonsai plants had been exported all over the world. The crane and pine motif representing longevity was prominent in the displays. Perhaps the most striking display was one depicting the four seasons. Once per year the roots of the bonsai plants are trimmed. Dipterex was used against foliage-feeding insects. The pots were placed on beds of sand to facilitate drainage. Examples of bonsai plants included: *Albizzia julibrissin* (mimosa tree), *Pinus*, *Juniperus chinensis*, *Malus halliana*, *Tamarix chinensis* (tamarisk), *Lagerstroemia indica* (crape myrtle), *Ginkgo biloba*, *Canna* (canna lily) and *Bougainvillia*. The delegation also noted *Magnolia*, *Camellia*, *Campsis radicans* (trumpetvine; imported from the United States about 100 years ago), *Ilex cornuta*, *Nandina domestica*, Japanese yew and tulip poplar.

Bei Qiao Commune

The Bei Qiao (North Bridge) Commune, located on the outskirts of Shanghai city, was established in 1958. It had a total of 5886 households (20,050 people, of which 12,600 were farm workers) divided into 11 production brigades (with 116 production teams) and one seed farm. It was located on an area of over 15,000 hectares. Crops included cotton (6777 ha, or about 40 percent of the commune's area), early and late rice, wheat and barley, plus vegetables, herbs, industrial crops (for example, hemp), and pigs.

Grain yields in 1978 were 12,958 kg/ha, an increase of 14 percent over 1977 yields (as opposed to 4000 kg/ha/year prior to the 1949 Liberation). Cotton yields were 1290 kg/ha in 1178, an increase of 60 percent over 1977 yields. These increased yields were attributed to two factors: (1) Excellent weather in 1978, and (2) high worker morale following the end of the influence of the "Gang of Four." In 1978, the commune raised 26,209 pigs, of which 13,080 were sold to the State market. Chickens, eggs and mushrooms were also produced of which 110,000 kg, 90,000 kg, and 150,000 kg were sold, respectively. There were three production brigades growing vegetables (peas, cucumbers, potatoes, tomatoes, watermelons, and so forth); in 1978, 9 million kg of vegetables were sold to the State. In all, 40 percent of the grain was sold to the State, 40 percent was given to the farmers, and 20 percent was used for seed and feed (for pigs).

Farm machinery on the commune included 21 irrigation pumping stations, 36 medium-sized and 124 small tractors, 147 rice transplanting machines and 339 threshing machines. Factories existed to repair farm tools and furniture. Some factories produced parts needed in Shanghai for light industry.

Ten years of schooling were required of all commune children, beginning at the age of 7 years. There were 12 primary schools and 1 middle school on the commune. Also, there was one hospital in the commune, and one clinic for each brigade (with three or four "barefoot doctors"), plus medical workers in each production team. The commune had a "broad medical insurance plan" which provided free medical care to the sick.

There were plant protection personnel (a total of 151) at each level within the commune: 5 at commune level, 16 at brigade level, and 130 at the team level. There was 1 forecasting station at the Commune level, and 6 of the 11 brigades had their own forecasting stations.

There were four general control measures: (1) cultural, (2) manual (pluck out insects by hand), (3) biological (see below), and (4) chemical.

Herbicides for weed control were used on an experimental basis only. The commune used 6000 kg of other pesticides of which 60 percent were synthetic organic insecticides and 40 percent were synthetic fungicides and antibiotics. The fungicides were used mainly for scab on wheat and *Sclerotinia* on rape.

The major pests of cotton in the area were: (1) Diseases--anthracnose, pink boll rot (caused by *Glomerella gossypii*), round spot, angular leaf spot (caused by *Xanthomonas malvacearum*), and *Fusarium* wilt; and (2) insects--pink bollworm, spider mites, and aphids. Integrated control measures were used to control these pests.

The biological control of cotton aphids program of the commune represented an example of the conservation approach in biological control; that is, the protection of natural enemies. In cotton these included ladybugs, chrysopids, spiders, anthocorids, and aphidiid parasites.

Cotton and wheat were produced in two ways on the commune, as follows. Method A: Cotton was sown into, or interplanted with winter wheat (which was planted in November) from early to late April. Then at the end of May or early June, the wheat was harvested. Most (70 percent) of the cotton was grown in this manner. Method B: The wheat was harvested, compost was applied, the stubble was plowed to a depth of about 22 cm and cotton was transplanted into the seedbed during early June. Only 30 percent of the cotton was planted in this manner. Method B yields were 5 to 10 percent higher than those of Method A.

The biological control program was carried out in cotton interplanted with wheat; that is, under Method A. Natural enemies were first protected in the wheat. [Major wheat aphids were *Schizaphis graminum* (greenbug), *Macrosiphum avenae* (English grain aphid), and *Rhopalosiphum padi*.] The wheat was not sprayed until there were more than eight aphids per wheat head, and then only the wheat heads were sprayed in order to protect the natural enemies. This could be done without reducing wheat yield, which averaged about 1500 kg/hectare. The natural enemies moved into the inter-planted cotton, where again they were protected as much as possible. Chemicals were used only when 20 percent of the cotton plants showed signs of aphids.

Using this method, the commune workers had been able to reduce the number of treatments for aphids from six to one per year. However, chemicals were still apparently applied for pink bollworm and spider mites (a total of six times a year for all three insect pests; 1000-2000 kg of Rogor plus 2000 kg of Sevin per year).

The commune was selecting for resistant cotton varieties including the traits of "hairiness" and "filled bolls." Apparently no entomologists were involved in the plant breeding program. (The cotton varieties were only selected on the basis of appearance and not on the basis of disease resistance or production performance in yield trials. The Shanghai Academy of Agricultural Sciences had introduced cotton varieties with resistance to *Fusarium* wilt, but the communes do not grow them because their yield potential is lower than for susceptible varieties. This problem seemed universal in China.)

No defoliants were used in cotton production at the commune. However, the cotton was "hand-topped." *Dibrachys* parasites were used to control pink bollworm in storage. Control of *Fusarium* wilt of cotton was apparently accomplished by the familiar rotation of cotton, wheat, early rice, late rice, wheat, cotton.

The gin was located on the commune. The cotton seed meal was used for fertilizer. About 60,000 kg/ha of organic fertilizer were used and plowed down to a depth of about 22 cm. Also, 10 kg/mu of inorganic nitrogen was applied as a top dressing.

The antibiotic #5406 was used on an experimental basis only. Its effectiveness had not been established. It was no longer produced on the commune.

HANGZHOU, ZHEJIANG PROVINCE, JULY 23

On Monday, July 23, the delegation visited the Zhejiang Academy of Agricultural Sciences in Hangzhou. The following notes include those taken during the visit to the Microbiology Institute of the Academy.

Hangzhou lay at 30° N and 30° 15' W. It enjoyed 252 frost-free days. Annually, temperatures fluctuated between -14° to 42° C. Winter wheat was sown at the beginning of November. About half of the wheat was grown in the winter and half in the spring. The rice stemborers *Tryporyza*, *Sesamia* and *Chilo* were serious pests. No citrus was grown in the Hangzhou area. Eighty percent of the people in the region were engaged in growing food. There was some interest in increasing the efficiency of food production per person but not at the expense of any yield reduction.

Like the Academia Sinica, the Zhejiang Agricultural Academy of Sciences received virtually all of its funding from the central government in Beijing. However, in an emergency, the province could provide funding for extension and action-type activities. By contrast, most universities (with seven exceptions, such as Zhongshan (Sun Yat Sen) University in Guangzhou), were largely dependent on the provincial governments for funding. Even the seven "national" universities received some funding from the provinces.

Zhejiang Academy of Agricultural Sciences (ZAAS)

The Zhejiang Academy of Agricultural Sciences was founded in 1935. The academy had been visited in 1957 by Premier Zhou Enlai and in 1958 by Chairman Mao Zedong. An exhibition hall had been established to commemorate these visits and one of the exhibits was a plow once used by Chairman Mao. The academy was moving forward under the joint leadership of "the Party and the Government at all levels," and was an "integrated research organization." The academy employed 900 persons. In addition, the academy had branches in various localities in the province; for example, the Corn Research Institute, and others, which employed an additional 800 persons.

There were nine institutes and one experimental farm in the academy. The institutes were: Rice Research, Crops Research, Soil and Fertilizer, Plant Protection, Horticulture, Sericulture, Animal Husbandry, Veterinary Science (including medical applications), and Microbiology.

The Microbiology Institute had two laboratories: (1) Agricultural Antibiotics Laboratory (15 research personnel and five assistants), and (2) Nitrogen Fixation Laboratory. In addition, there was a special group that studied antibiotics for additives for animal feed, and one experimental (pilot) plant for production of microbiologicals (23 workers). In all, the institute had 33 researchers and 8 assistants, involved in eight areas of research.

Antibiotics research began in 1970 to replace, as much as possible, the use of chemical pesticides, the overuse of which had caused environmental damage, pollution and health hazards. Their goal was high crop yields with low toxicity. The work was motivated by the need to find substances that were ecologically selective, had short residual life and which posed little hazard to people. The staff felt strongly that such materials could be found in microbial preparations. There was very strong political support at all levels for this mission and approach.

There were four major target pests, for which studies had recently been begun: (1) Bacterial blight of rice, (2) wheat scab, (3) rice leafroller, and (4) barnyard grass (Panicum), a rice paddy weed. They screened about 7000 "strains" of antibiotics (actinomycetes) from the soil each year, using the silkworm as a bioassay. An *in vivo* method was used to discover useful microbial preparations. Basically, this involved applying the antibiotic to the plant and then adding the pest (insect or pathogen) or by applying the microbial preparation directly to the pest, off or on the plant as appropriate. Experience had shown that the *in vivo* method was superior to the *in vitro* method for this type of research. Several kinds of antibiotics had been found and tested in the recent past; for example, anisomycin and azalomycin.

One current research area concerned an aphicide, previously called "No. 26 insecticide," but then described (though not then yet published) as *Streptomyces griseolus* var. *hangzhouensis* Yan et Fang n. var. This was screened from bamboo soil in a mountainous area of Zhejiang Province in 1972, and had proven effective in controlling aphids in cotton, vegetables, and sorghum, and apple and cotton spider mites. It had demonstrated "exceptional specificity," giving protection for natural enemies (coccinellids, chrysopids, syrphids, and aphidiids). The mode of action of the aphicide was unknown. Only one fraction was effective against aphids; however, the entire beer was

applied. The aphicide was an endotoxin. However, an exotoxin was produced which controlled both gram positive and gram negative bacteria. It was not known whether the active ingredient acted by destroying the symbiotes in the aphid. The aphicidal endotoxin had been extracted and purified. IR, UV, and NMR spectra indicated that the endotoxin might be an entirely new type of antibiotic.

The new variety differed from the type species, S. griseolus Waksman, in several physiological characteristics; for example, it did not liquefy gelatin, it strongly hydrolyzed starch, and so forth These differences were illustrated on a chart (see Appendix 16).

This antibiotic was applied in the field as an external spray, the whole organism in water, 10-15 ppm, with 0.005 to 0.01 percent bleaching powder. There had been 5 years of field experiments with the antibiotic. The experimental area in 1979 was 10,000 mu. At 10 to 15 ppm, the antibiotic was 80 percent effective on cotton and tobacco aphids, and red spider mites on apples and cotton. Effectiveness was stated to be "fundamentally equal to that of rogor," and besides it was "safe for natural enemies."

Characteristics of the aphicide were given as follows:

(1) Scope of control: Several years' experience had shown it could control cotton, tobacco, vegetable and sorghum aphids, and spider mites on apple and cotton. Experiments had also shown some effectiveness on cabbageworms, armyworms and the rice leafroller.

(2) It was a contact poison, and thus had to be applied to the insect externally.

(3) Below 15° C, effectiveness declined markedly.

(4) It decomposed very quickly, retaining toxicity only three days in the field.

5) It was "highly selective."

6) At 10 to 15 ppm concentration, it gave 80 percent control. No evaluations had been made of higher concentrations. Those concentrations were harmless to coccinellids and Chrysopa. Six different organizations had evaluated the material against eggs, larvae, and pupae of coccinellids and mortalities in all cases fell into the range of 0 to 18.5 percent, which differed little from mortality in unsprayed areas [no real "check plots" had been used apparently].

When rogor was used to control aphids on cotton, the aphids and their natural enemies were destroyed, and the aphid population recovered rapidly. However, when the antibiotic "Preparation #26" was used, the natural enemies were spared. The application date was May 26. By June 5, the coccinellids had left the field; however, anthocorids moved in and a population of these predators built up on Heliothis eggs.

Short-term toxicological studies had been completed. The acute oral LD on white rats was 68 mg/kg. Dermal toxicity could not be detected on white rats up to 100 mg/kg. Long-term toxicological studies had not been

conducted. The taxonomic aspects were to be published at the end of 1979. The other results had been submitted in manuscript form to Acta Microbiologica Sinica.

At that time, no work was underway on antibacterial preparations. Also, no work was underway on developing the use of viruses or bacteria to control insects. The work against Panicum was only recently initiated.

The laboratory demonstrated a Bombyx mori bioassay. Mulberry leaves were dipped in the total broth. Active fractions were separated on silica gel columns and bioassayed on Bombyx larvae on filter paper in petri dishes. Active fractions were further separated by means of thin layer chromatography.

The academy had made no progress on antibiotics for bacterial blight of rice or wheat scab. It did the race identification work for Piricularia oryzae (rice blast) in the People's Republic of China.

HANGZHOU, ZHEJIANG PROVINCE, JULY 24

On Tuesday, July 24, the delegation visited the Plant Protection Department of the Zhejiang Agricultural University of Hangzhou. The following are notes on that visit.

Zhejiang Agricultural University, Plant Protection Department

Zhejiang Agricultural University had a history of 78 years. It was founded as a provincial agricultural technical school in 1901, and was later incorporated into National University of Chekiang (Zhejiang) as an agricultural college in 1928. After liberation, the college was completely reformed and reorganized as an independent institution known as Chekiang Agricultural College in 1952. Since 1960 the college had adopted its present name Zhejiang Agricultural University.

The university attained its highest record of enrollment of about 2700 undergraduates before the Cultural Revolution. Since the establishment of the People's Republic, the number of students graduated from this institution had accumulated to about 8000.

The experimental farm around the campus had a total acreage of over 1000 mu.

The university had nine academic departments comprising 14 "specialities," along with a Division of Basic Courses.

Department	Specialities
I. Agronomy	1. Agronomy (Crop Science) 2. Seed Technology
II. Soil Science and Agricultural Chemistry	3. Soil Science and Agricultural Chemistry 4. Environmental Protection
III. Plant Protection	5. Plant Protection

Department	Specialities
IV. Sericulture	6. Sericulture
V. Horticulture	7. Pomology 8. Vegetable crops
VI. Tea Culture	9. Tea Culture
VII. Animal Husbandry and Veterinary Science	10. Animal Husbandry 11. Veterinary Science
VIII. Agricultural Machinery	12. Design and Manufacturing of Agricultural Machinery 13. Design and Manufacturing of Tractors
IX. Agricultural Economics	14. Agricultural Economics

The university had a teaching and research faculty totaling about 500 members. Of these members, 27 were professors; 31, associate professors; 275, instructors; and 167, assistants. The enrollment of students amounted to over 600 in 1978.

The Plant Protection Department of the university had a current enrollment of 150 students, and 2 postgraduate students. Cornell University was to place one student in agronomy and soils at this University in September 1979 for 1 year.

The department had a collection of parasites of rice insect pests collected throughout China, consisting of 88 of the 200 such parasite species then known in China. Of interest were specimens of Apanteles flavipes from Sesamia inferens (the purple stemborer) and Chilo sp.; Bracon onukii from S. inferens and Chilo suppressalis; and Stenobracon nicevillei and Tropobracon schoenobii (Vier.) from Tryporyza incertulas. The department had a collection of 40,000 specimens of beneficial insects collected throughout China, in addition to 60,000 specimens in the "general collection" for a total of 100,000 specimens. Most of the specimens in the beneficial insect collection were hymenopterous parasites (there were about 160 boxes of ichneumonids, each with a single species), with very few tachinids or predators. The biological control work of the department had just begun, the first step being identification of natural enemies. In addition to taxonomic studies of chalcidoid and ichneumonid parasites, studies were being conducted on the biological control of insects on trees, including mulberry, pear, peach, and citrus (apples were said to be absent in the Province).

The department had done work on Chinese gall aphids on Rhus. Rhus chinensis had a high tannin content and the galls had a very high tannic acid content. The galls were used for tanning leather and for ink production. The following five Chinese gall aphid species occurred on Rhus chinensis: Schlechtendalia chinensis, S. peitan, Nurudea sinica, N. shiraii, and N. rosea. On Rhus punjabensis var. sinica, the following gall aphid species occurred: *Kaburagia ovogallis, *K. ensigallis, *Meitanaphis elongallis, M. flavogallis, and *Floraphis meitanensis [an asterisk (*) means the species also occurred on Rhus potania]. Some aphids and other insects were serious

pests of Rhus in China, and might have potential for biological control of poison ivy and poison oak. The following species of trees of the Rhus section [or subgenus] Toxicodendron occurred in China: (1) verniciflua Stokes (=vernicifera D.C., vernix Thunb. nec L.) (in Fujian and Hunan Provinces and central China; the "varnish tree," a tree of economic importance); (2) sylvestris Sieb. & Zucc. (central China, Japan, Korea); (3) succedanea L. (in Jiangsu, Jiangxi, Hubei, Sichuan, Yunnan and Guangdong Provinces; the "wax tree," of economic importance); (4) delavayi Franch. with var. quinquejuga Rehd. & Wils. (Sichuan Prov); and 5) trichocarpa Miq. (Jiangxi, Hubei, Fujian Provinces and Japan). The major pest of Rhus (Toxicodendron) verniciflua was a chrysomelid, Podontia lutea, which occurred in Zhejiang, Guangdong and Yunnan Provinces.

The department studied integrated methods of controlling rice insects (including stemborers, leafrollers, and leafhoppers) and bacterial blight of rice, as well as the selection of resistant rice varieties; and studies on the biological control of cabbage insect pests, and insectary culture, were also conducted.

Stemborers were once a problem in the area but had become less so. However, with the introduction of hybrid rice beginning in 1966, stemborers had again become more serious pests. However, the most serious pests in the area were plant- and leafhoppers and the rice leafroller, Cnaphalocrocis medinalis (Pyralidae). Thrips were also a problem, especially in the rice seedling stage. The brown planthoppers migrated into the area from the south, appearing in the field in mid-June; heavy populations built up by the time of heading of the rice, when they were most serious pests. Injury thresholds ranged from 0.5 to 4 insects per plant and later in the season to as much as 8 to 15 per plant, depending on the stage of plant grown.

Trichogramma provided about 50 percent parasitism of the stemborers which was not enough for economic control. The best rice variety for resistance to plant- and leafhoppers was "IR-26." Malathion and rogor were used to control the hoppers, along with a fungicide mixture which had some effectiveness on the hoppers as well as fungal pathogens.

Work on cabbage pests had just begun, and involved two areas: (1) Survey of natural enemies; and (2) use of insect virus (a Pieris rapae granulosis virus received from Dr. N. W. Hussey, Glasshouse Crops Research Institute, England).

Collections of Pieris rapae eggs, small larvae, and pupae, had been made from many provinces of China for the natural enemy survey, and returned to the Hangzhou laboratory for parasite emergence. It was found that all of the major parasites found in the survey were found in Zhejiang Province. Some of the parasites found were Pteromalus puparum (a major parasite, found attacking 45 to 50 percent of the winter generation of P. rapae in 1979) and Brachymeria lasus and B. sp.(?) (particularly in Jilin Province) and Dibrachys (all pupal parasites). Results of the survey were eventually to be published. Some P. rapae parasites reported to occur in China in literature were found to be very rare during the survey; for example, Trichogramma, recorded from Pieris in the south, was found in southern China only in about 1 of 10,000 eggs collected during the surveys. (However, it was noted that Trichogramma was more effective against P. rapae in northern China.) Apanteles glomeratus was

found to be also very rare during the surveys. One reason for the scarcity of these larval and egg parasites, and the apparent preponderance of pupal parasites, might be the heavy use of insecticides on cabbage; treatment was almost every week. Pieris rapae was highly resistant to the insecticides used (rogor and DDVT). There were eight generations of P. rapae in the area per year, according to Shanghai data.

The department had experimented with the release of Pteromalus puparum for P. rapae control on a small scale. After releasing 7000 females per mu on a total area of 30 mu (that is, 2 ha) 76 percent parasitism of P. rapae was obtained. The Department would like to test the release of larger numbers of these parasites.

The department imported Apanteles rubecula from Canada (in 1978) from a laboratory culture obtained from Dr. J. Kelleher, Canada Agriculture, Ottawa. A shipment of 18 non-diapausing and 100 diapausing cocoons was received, and the species was in culture at Hangzhou in July 1979, though they had experienced diapause problems with the parasite and disease problems in the host culture.

Other problems on cabbage in the area included the diamondback moth (Plutella xylostella), the green peach aphid, and Rhopalosiphum pseudobrassicae [=Hyadaphis erysimi] (no cabbage aphids were said to occur in this area; they occurred only in North China). The fungus Beauveria bassiana was formerly used against P. xylostella, but no longer. An attempt was being made by the Horticultural Institute, Zhejiang Academy of Agricultural Sciences, to apply the sterile insect technique to the suppression of Plutella xylostella, the diamondback moth, using a radiation dose of 35,000 roentgens. But, males treated with this dosage did not perform well. Bagworms, Clania sp. (Psychidae), seemed to be a problem on shade trees in the area.

The plant pathologists of the department had once worked on Beauvaria as an agent for biological control of insects. This work had been closed out during the last 2 years, and they now worked only on plant diseases. Their laboratories were generally simple. There were a small and quite new sterile-air bench and a new compound Zeiss microscope, but mostly only tables, benches, and very simple apparatus. The teaching laboratory was well supplied with diseased specimens, in Riker mounts or preserved in liquid jars.

The important diseases in China were as follows:

Cereal grains. There were five viruses on rice, including mycoplasma-like organisms (MLO). Of bacterial diseases, leaf blight caused by Xanthomonas oryzae was most important and continued to prove very difficult to control. Xanthomonas oryzicola was the second most important bacterial pathogen of rice. The Zhejiang University pathologists stated that bacterial "stripe" was also important on wheat, and were undertaking to sort out the Fusarium organisms responsible for scab. There was an unconfirmed report of Stewart's wilt of corn in Zhejiang Province. Of the fungus diseases of rice, blast continued to be most important. A new variety of rice lasted only 4 to 5 years. There was a nationwide association on rice blast that was headed by the Zhejiang Academy of Agricultural Sciences, and another on bacterial leaf blight led jointly by the Jiangsu and Guangdong Provincial Academies of Agricultural Sciences in Nanjing and Guangzhou, respectively.

Rice black streak dwarf (spherical particle, vectored by the planthopper) became very serious starting in 1963. The.disease occurred on rice, wheat, corn and barley. The rice crop on some brigades was nearly completely destroyed. The disease remained serious until 1967 but was currently controlled, in part by insecticides, but possibly also by an unknown factor. After 1967, the disease stopped so abruptly that the workers could not find a single specimen. Chemical control involved spraying the barley or wheat just before harvest to kill the planthopper and cut off the migration cycle. They also applied oil to the paddy water to suffocate the nymphs. But why the disease disappeared so abruptly was a mystery. Rice dwarf virus and rice yellow stunt became a problem starting in 1963, and lasted until 1973. Both were rhabdoviruses carried by leafhoppers. Again, the diseases were so severe that some brigades had virtually total crop failure, but again the diseases seemed to subside, although not as abruptly as occurred with rice black streak dwarf. The control was almost the same, but spraying was done just after harvest of the wheat or barley. Insecticide had to be applied all around these fields, as well as the nursery blocks of rice seedlings. Early rice had to be sprayed, and the early seedlings of late rice had to be sprayed. Initially, the leafhopper vectors from nature were 40 to 50 percent efficient in transmission, but currently the hoppers gave almost zero transmission. There might be "races" in the vector, and a race resistant to the virus might have replaced the original vector race. The mechanism could be caused by the virus affecting the vector strains and making it less competitive. Seven groups of races of Piricularia oryzae were known, with probable related races in each group.

Potatoes and Sweet Potatoes. Potato soft rot, ring rot, and southern bacterial wilt were all important bacterial diseases. A three-way cooperative association on ring rot of potato involving Beijing Agricultural University, Inner Mongolia, and Keshan in Heilongjiang Province was established. On sweet potato, a new and very serious bacterial disease had turned up locally in Zhejiang Province but the cause was still unknown. The most important disease on sweet potato might be black rot caused by Ceratocystis fimbriata. The nematode Ditylenchus dipsaci was also a pest of sweet potato.

Vegetables. Southern bacterial wilt was the most important bacterial disease of tomato in China, with soft rot bacteria as the second most important bacterial problem in vegetables. Soft rot was also important on cabbage and might be the most important bacterial disease group for all vegetables. An unidentified bacterial disease had turned up on ginger in Zhejiang Province, but the agent had not yet been identified. It was learned that crown gall occurred in China. The disease occurred on beet in Inner Mongolia, and occurred elsewhere in China on peach and apple. Among the vegetable diseases, tobacco mosaic virus (TMV) was a very important virus; on tomato in Zhejiang Province, it caused about 20-percent fruit drop. The department had attentuated strains from the Microbiology Institute in Beijing for cross protection. Chinese cabbage (the small variety) was seriously affected by TMV, turnip mosaic and cucumber mosaic viruses (CMV). TMV was soilborne in Zhejiang Province. Among the fungal diseases on vegetables, downy mildew was very important on cucumbers, and Fusarium wilts were important on cucumber, tomato and potato. Verticillium was important on eggplant.

Miscellaneous crops. The root knot nematode was important on peanuts in Shandong Province in particular. Soybean cyst nematode occurred in the Northeast. In tobacco, there were both the yellow strain and common TMV.

Another virus disease recently discovered was curly mosaic, a disease characterized by rolling of the leaves. Virus diseases were also important on oilseed rape. The original introductions of oilseed rape were highly susceptible to turnip mosaic in particular, but also TMV and CMV. A resistant rape variety was released and controlled turnip mosaic about 10 years ago, but the incidence of virus infection was rising again for reasons unknown. Another control method against turnip mosaic in rape was to control the aphid vector.

HANGZHOU, ZHEJIANG PROVINCE, JULY 25

On Friday, July 25, the delegation visited the Tea Research Institute of the Chinese Academy of Agricultural Sciences. The following are notes on that visit, and a brief report on the PRC Survey of Natural Enemies of Agricultural Pests.

Tea Research Institute, CAAS

The Tea Research Institute of the Chinese Academy of Agricultural Sciences was established in 1958, and currently had a staff of 150. It had responsibility for tea research throughout the People's Republic of China. (Prior to liberation, there was no institute specifically for tea research.) The institute had seven research divisions and an administration office and experimental farm. The seven divisions were: Tea Tree Culture Research, Tea Seed Culture Research, Plant Protection (Tea Pests and Diseases), Tea Physiology and Biochemistry Research, Tea Processing Research, Tea Machinery Research, and Tea Literature and Information. There had been many research achievements at the institute, but it was noted that biological control was an area only recently entered and results were not yet remarkable.

Tea (many varieties) was grown mainly in South China. There were about 300 pests of tea, including 100 diseases. The most important pests were: (1) tea looper, *Ectropis obliqua*; (2) coconut scale, *Aspidiotus destructor*, and peach scale, *Leucaspis* [=*Lopholeucaspis*] *japonica*; (3) the mites *Acaphylla theae* and *Brevipalpus obovatus*; (4) leafhoppers; and (5) diseases (blister blight, caused by *Exobasidium vexans*, which was important especially in southwestern China, and brown blight, caused by *Guignardia camelliae* (the perfect stage of *Colletotrichum camelliae*), which was especially serious in Zhejiang Province; root knot nematodes were also important pests of tea in many areas of China).

Because of the greater leaf area of tea than that of other crops, and the use of the leaves, leaf insects and diseases were more important than in some other crops, and required more pesticides. Heavy use of pesticides began in the 1950's. But chemicals had caused residue problems and disrupted natural control of the pests. In 1970, the use of "#223, #1605," DDT and BHC on tea was banned. Only those chemicals that had low residual action could then be used on tea. Chemicals used on tea had to undergo tests to determine their risks to human health. Chemicals then in use included: Dipterex, DDVP, Phoxim, Malathion, Rogor, Permethrin, dicofol, and NRDC 143. Against leaf diseases, Topson, Dithan, and Actidione were used, with one or two sprays per year. The root knot nematode had been especially difficult to control; they used DD or DDCP. The nematode was apparently the greatest problem when the tea plants were young.

Biological control research began at the institute in 1970. The following research areas were currently under study.

1. Survey of the natural enemies of tea pests. About 100 species of natural enemies had been found in China, of which 80 occurred in Zhejiang Province. (No egg parasites of the tea looper had been found.)

2. Application of natural enemies (primarily aimed at the tea looper).

(a) A new fungal pathogen, Cordyceps sp., had been screened from locally collected tea looper larvae and pupae. Natural infection was low, "practically zero." But when sprayed on tea at 20 to 30×10^6 conidia/ml, infection of looper larvae by Cordyceps reached 80 percent within 10 days. This ascomycete infected through the cuticle and mouth parts and formed a stroma. Its effectiveness depended on relative humidity and temperature. Best results were achieved in autumn and spring. In summer, the temperatures were too high and the humidity was too low. Further research was underway.

(b) An undetermined Apanteles species (possibly two species) attacked tea looper larvae. Natural parasitism reached a high of 80 percent. Maximum parasitism occurred from April to June, declined during July to September, and ceased by October, when the parasite apparently entered diapause. The Apanteles had 11 generations a year in the laboratory, with a life cycle of 12 to 14 days from egg to adult; the adult lived only 1 to 2 days. The species was a solitary parasite (one offspring per host) and the female attacked 12 to 13 host larvae during her life span. More research on the possible use of this parasite was needed. (See Appendix 5 for identification of these parasites.)

(c) An NPV had been isolated from the tea moth, Euproctis pseudoconspersa. An application dosage of 1 ml with a concentration of 0.11×10^9 PIB to 0.1 mu could cause 100 percent mortality of the tea moth larvae. The amount of NPV that could be harvested per host larva was 0.16×10^9 PIB.

(d) Ladybugs (Chilocorus kuwanae) were being used to control the peach scale, Leucaspis japonica. The ladybug had three to four generations per year, and could overwinter at temperatures as low as -4° C. Releases of four ladybugs per tea tree had resulted in 80 percent suppression of the scale.

Biological control research was also being carried out on tea in other areas of the People's Republic of China. For example, in Anhui Province, Trichogramma, mainly T. dendrolimi, was being used to control the tea leafroller [=Adoxophyes orana or Gracillaria theivora?]. Releases totaled 50,000 to 120,000 Trichogramma per mu, divided between three treatments per year. Results of 3 years study showed an average of 60 percent, and a maximum of 80 percent, parasitism by this treatment. Also, apparently in Sichuan Province, the use of predatory mites, Typhlodromus sp., was being studied for mite control on tea.

Research on the sex attractant of the tea leafroller had been initiated. The institute had been preparing active extracts, bioassaying them in a bamboo water trap and sending purified fractions to Shanghai. It did not have a GC-MS nor an NMR spectrometer, but had good gas chromatographs. Sex attractant traps captured up to 130 males per night. The extract placed on filter paper remained active for 3 to 4 consecutive nights. An attempt was also to be made to identify the pheromone of the smaller tea tortrix, Adoxophyes orana.

A major problem in the institute's work on analytical methods for pesticide residues was the interference from caffeine. The institute was currently working on an analytical method for NRDC-161, obtained from France.

Report on PRC Survey of Natural Enemies of Agricultural Pests

The national survey of natural enemies in which PRC entomologists were then engaged had two centers for this activity: Beijing Agricultural University in North China, and Zhejiang Agricultural University in South China. The survey had just begun in 1979, and was scheduled to last 3 to 5 years.

There were 1-month training courses scheduled every 6 months for the next 3 years. In the North, the first course was held in May 1979, in a locality in Beijing Municipality; in the South, it was held in February in Hangzhou. The training courses were designed to instruct the survey technicians. They were to consist of about 80 people per session. The people attending the spring training session were to return for a fall session, with specimens collected during the interim. Eventually all pertinent personnel from all provinces were to receive such training.

The importance of the surveys for biological control was stressed at the spring training session, and morphological characteristics of orders and families were taught, as well as survey techniques (collection, preparation, recordkeeping) according to crop areas. In the fall sessions, discussions with taxonomists were to be held to help further training in regard to identification.

The survey teams in Beijing provided an example of the survey work itself. The survey team had 10 technicians from (1) Beijing Municipal Plant Protection Station, (2) Beijing Academy of Agricultural Sciences, and (3) Beijing Agricultural University. Each unit of the team was to cover specific crop areas. They were to meet jointly for 2 days each week to discuss results and plan further activities, and for the rest of the week they were to split into units for specific collection activities. There were apparently to be such survey teams for each province of the People's Republic of China.

The collections were to be deposited primarily in Beijing and Hangzhou Agricultural Universities. A major publication was to be a result of this survey in 5 or 6 years.

A textbook on biological control was being prepared in the People's Republic of China, with a manuscript deadline of December 1979. Ten to 12 people were on the editorial board, which met in April 1979, at Zhejiang Agricultural University.

GUANGZHOU (CANTON), GUANGDONG PROVINCE, JULY 27

On Friday, July 27, the delegation visited the Biology Department of Guangdong University, the Guangdong Institute of Entomology of the Chinese Academy of Sciences, and held discussions with the plant pathologists of Guangdong Academy of Agricultural Sciences. The following are notes on the visits and discussions.

Zhongshan University, Biology Department

The Zhongshan University (=Sun Yat Sen University) was one of the seven "key" universities in the People's Republic of China, the other six being Beijing, Wuhan (in Hubei Province), Fudan (in Shanghai), Xiamen (in Fujian Province), Sichuan, and Lanzhou (in Gansu Province) Universities. These universities were under the direct administration of the People's Republic of China Ministry of Education, Beijing.

The university was established by Dr. Sun Yat Sen (also known as Zhongshan) in 1924 as Guangdong University. The name of the University was changed in 1926 to honor its founder, who also led the revolution in 1911 in China and was considered founder of the Republic. The university had 15 Departments as follows: Natural Sciences -- Fluid Dynamics, Computer Science, Physics, Electronics, Chemistry, Geography, Geology, Meteorology and Biology; and Liberal Arts -- History, Chinese Language and Literature, Philosophy, Economics and Foreign Languages. An Oceanography Department was to be established. In each department there were several "specialities" and "teaching-research" groups, a total of 33 specialities and 52 teaching-research groups. The university had a main library (about 2,400,000 books), and each department maintained its own smaller library.

In addition to the department structure, and independent of it, were six research institutes, some only recently (1979) established. They had charters to conduct long-term, mission-oriented basic research. The six institutes were: High Polymer Chemistry Research Institute, Computer Science Research Institute, Environmental Research Institute, Entomology Research Institute (established in 1979), Mathematics Research Institute and Southeast Asian History Research Institute. In addition, there were 18 smaller research laboratories under the administration of various university departments; for example, under the Biology Department, there were a Botany Laboratory, Fisheries Laboratory, and Parasitology Laboratory.

The university had a staff of 1200, including 130 professors and associate professors, and 450 lecturers (the remaining staff being teaching and research assistants, and others). Students numbered 3700 during the 1979 term, but by the next term this number was expected to increase by 1500. Graduate training at the University had ceased with the onset of the Cultural Revolution, and was resumed in 1978, with 106 graduate students, among which 24 studied under the Biology Department.

The basic undergraduate curriculum was four years, with a stress on basic theory and its applications. Students studied the basic subjects (mathematics, physics, chemistry) for the first 3 years, being allowed specialized subjects in the fourth year.

Basic and theoretical studies and research resumed at the university by 1979. This was one reason for the establishment (or re-establishment) of research institutes, which were largely oriented toward basic research, at the university.

The Entomology Research Institute, established in 1979 as an outgrowth of the previous Insect Ecology and Taxonomy Laboratories of the department, had the following three research emphases.

1. Insect Taxonomy. The department (institute) had an insect collection consisting of about 200,000 specimens, primarily from southern China; it was ranked as third in China, after that of the Zoological Institute in Beijing and of the Shanghai Institute of Entomology. The collection was particularly strong in Orthoptera (Gryllidae), aquatic and longicorne Coleoptera, and Hemiptera (Pentatomoidea, Coreidae). There were three taxonomists in the department (institute) (see Appendix 8). Napthalene and "closed windows" were used to combat the humidity problems prevalent in this area of China.

2. Insect Ecology. This concerned primarily experimental field ecology, with emphasis on the life table approach. Life tables of several insects were being studied.

3. Insect Pathology. The use of various microorganisms to control pests was studied at the institute, including quite detailed basic research. In the past they had studied *Bacillus thuringiensis*, developing use patterns for this organism. But more recently, insect viruses had been studied, including CPV (RNA virus) and NPV (DNA virus) of *Dendrolimus* species (pine caterpillars) (CPV was used as the field control agent) and NPV of *Prodenia* [=*Spodoptera*] *litura* (cotton leafworm) on vegetables. There was large-scale rearing of *P. litura*, using an artificial diet consisting of soybean flour and soybean leaf powder, for virus production at the institute. A crude preparation of infected larvae was sprayed on crops. Initially, both CPV and NPV were used against *Dendrolimus* in northeastern China, but only CPV showed up in subsequent field collections; so only CPV was used by 1979. Diseased pine caterpillars were field-collected (after area treatments) for virus production. The health of personnel working with the CPV was closely monitored; no ill effects had been found after "several" years of CPV use. Toxicological tests had been conducted with the CPV using white rats, including eye irritation, subcutaneous, intravenous, and *per os* feeding tests.

The institute had recently published an article on rickettsia found in mass-reared *Trichogramma*. The organisms were first found in the culture of *T. dendrolimi* produced by the Guangdong Plant Protection Institute. Infected wasps had vestigial wings, reduced lifespan and reduced vitality. The rickettsial infection was not considered to be a limiting factor in the mass-rearing of *Trichogramma*. When *Trichogramma* was reared on *Philosamia*, the disease appeared, but the disease symptoms disappeared when *Trichogramma* was cultured on different host species; hence, nutrition determined the expression of the disease. The rickettsia was present in many *Trichogramma* wasps which showed no symptoms. Rickettsia had been found since then to be quite common in *Trichogramma* cultures throughout China, though some areas were free of the disease. The disease was being studied because of potential health problems for humans, since *Trichogramma* was so widely cultured in the People's Republic of China, and some rickettsial organisms were known to be detrimental to the health of man and animals in that they caused lung disorders. Similar findings had been reported from the Institut für Biologische Schadlingsbekampfung in Darmstadt, Federal Republic of Germany.

There was a need for standardization of *Bacillus thuringiensis* (*B. t.*) in the People's Republic of China. Fermentation plants generally did not have an entomologist for this purpose. The French used *Anagasta kuehniella* whereas Americans used *Trichoplusia ni* for bioassay. The Chinese had tried *Anagasta* but had found the silkworm, *Bombyx mori*, to be more useful for bioassays. Viable silkworm eggs could be purchased and stored for up to 4 months. This

was most useful for B. t. factories in the People's Republic of China, since no insect cultures were required. The B. t. was applied to the chorion and the neonate larvae ingested a given amount of chorion and B. t. upon hatching. The People's Republic of China had no universal reference standard.

The HD-1 strain of B. t. was brought to the People's Republic of China from Canada in 1975 as reference specimens. Several provinces, including Hunan, were producing HD-1 by 1979.

A Lymantria dispar NPV was used for control of the gypsy moth in Harbin, Heilongjiang Province in northern China. This virus was judged to be more potent than the virus used against the gypsy moth in the United States (that is, Gypchek). Also, it was learned that Heliothis armigera NPV, Trichogramma, spiders, and other entomophages were used for control of H. armigera in cotton in north central People's Republic of China (Jiangxi and Hubei Provinces). The major center for research on Heliothis in the People's Republic of China was the Biology Department of Wuhan Normal University (=Central China Normal College) in Hubei Province.

The Entomology Research Institute had a cooperative arrangement with a people's commune 65 km from Guangzhou. There, institute scientists conducted research on management of rice and cotton insects as well as life table studies on leafrollers. The institute also studied the ultrastructure of the Malpighian tubules of Philosamia cynthia ricini, the laboratory host used for Trichogramma culture in this area. Ducks were used for control of planthoppers and leafhoppers in rice in Guangdong Province. Beauveria bassiana had also been used for leafhopper control in the past, though not in this area. Excellent results in preventing rice burns caused by hoppers were being obtained in Hunan Province. The institute was attempting to select a special cultivar of rice for this purpose. From 1975, the local commune, where these integrated control measures were being tested, had reduced the use of insecticides in rice by 80 percent.

Some viruses vectored by plant- and leafhoppers had seemingly disappeared in recent years, probably due to (1) use of resistant varieties of rice, and (2) use of optimal seeding dates.

The insecticide Mipcin was used against leafhoppers in June and August, with two or three sprays in each month. Leafhoppers were vectors of the rice yellow stunt rhabdovirus, a major rice disease in Guangdong Province. The insecticide sprays prevented losses of yield of about 50 percent. China had developed dwarf rice varieties before the International Rice Research Institute (IRRI), but such varieties were not acceptable to the peasants.

The delegation learned that rice black streak dwarf virus occurred during 1963 to 1967 and that rice dwarf and rice yellow stunt viruses had been the main threat in the People's Republic of China since 1967. There were two peak periods where brown planthoppers had to be sprayed: Mid- and late-June and again in August-September. During the first period, the spray had to be applied to the nurseries. Mipcin was applied two or three times per peak period. This applied to Guangdong Province. Without a spray program, rice yellow stunt in particular would return and might claim as much as 60 percent of the rice crop. The rice virus diseases all showed up first in Guangdong Province, were controlled there by 1979, but gave trouble still in Zhejiang, Fujian, and other more northerly provinces of South China. The problem apparently came with the semi-dwarf varieties.

The insect pathology laboratory was equipped with a Hitachi HU-12A electron microscope with a scanning accessory. The laboratory was also equipped with an ultracentrifuge and there were plans to purchase an analytical ultracentrifuge to measure sedimentation coefficients. Other equipment included a Hitachi HUS-5 high vacuum evaporator, a Hitachi SSP-2 automatic preparative ultracentrifuge, and a Hitachi DGF-U density gradient fractionator.

The institute had ongoing studies to determine the optimal physical environment for mass-rearing the cockroach Opisthoplatia orientalis. This cockroach was used as a basic ingredient in a traditional medicine for accelerating the mending of broken bones and for treating liver disorders. The preparation was made simply by boiling the cockroaches; the soup was drank. Another institute was attempting to isolate and identify the active ingredient(s) of this preparation.

The Guangdong Institute of Entomology, Academia Sinica, was developing a biological control method for the litchi stink bug, Tessaratoma papillosa, in cooperation with Zhongshan University scientists.

Discussion with Plant Pathologists of the Guangdong Academy of Agricultural Sciences (GAAS)

The important peanut diseases were southern bacterial wilt (Pseudomonas solanacearum), Cercospora leaf spot, and peanut rust. Usually two crops of peanuts were grown per year, the first in March to July and the second in August to October. Wheat was then grown between October and March. Bacterial wilt could cause up to 10 to 15 percent loss. Peanut rust caused 30 percent loss generally and as high as 50 percent loss. No peanut variety was immune to rust, but some were moderately resistant. Early planting of the first crop and late planting of the second crop was practiced as methods of cultural control. Chemical control with chlorothalonil (Bravo) or sometimes even colloidal sulfur or Bordeaux mixture was also attempted. Nematodes were rare on peanuts in this Province, because the peanuts were rotated with paddy rice. On the other hand, the peanut nematode was serious in Shandong Province, where it occurred in economic proportions on 100,000,000 of the 200,000,000 mu of peanuts grown in that Province. There was a Peanut Research institute at Laixi in Shandong Province.

Bacterial blight of rice was the second most important disease on rice after blast. (The third most important disease at the time was sheath blight; the three diseases combined caused estimated losses in Guangdong Province of 150 to300 million kg per year.)

Xanthomonas oryzae caused both a leaf blight and a wilt. Wilt occurred if the pathogen strain was highly virulent, the rice variety very susceptible, there was a large amount of inoculum, or if the pathogen entered through root wounds caused by transplanting the rice. The main control was by moderate resistance in the cultivars and prevention of infection in the nurseries. "Prevention" required that the soil be just moist enough for good rice growth, but not excessively wet.. Some control was obtained with a systemic bactericide, 10 percent phenazin (phenazin oxide). This material was originally from Japan but was now made in the People's Republic of China. Several other chemicals, "ATDA" ("TF-128," apparently also known as diazol), "TF-130," and Cellocidin, were more effective but left serious residue problems and were not acceptable for this reason.

The problem of bacterial blight started mainly in the rice nursery, the source of the primary inoculum. The problem was greatest with production of the second crop of seedlings. If the nursery was overflooded to the extent that the leaves were under water, the bacteria could readily enter the stomates. Too much nitrogen also favored the disease. Some forecasting was carried out; for example, when a typhoon was predicted, known infection centers in the fields were spot-sprayed since spread from these spots was certain during high winds and driving rain.

Bacterial phages specific for X. oryzae were used to estimate populations of the pathogen in water, soil suspensions, or on seeds and leaves (plant parts had to be washed or somehow suspended in water as well). A count of 1500 phage plaques per ml of water was a threshold number and indicated that an outbreak of blight could be expected within 10 days.

Varieties with resistance were available in the breeding program but were far from being commercially acceptable. Any new variety had to be high-yielding and short-strawed as well as resistant to blast. Resistance to blast alone was a full-time breeding effort.

Blast occurred mainly in the hilly areas where nights were cooler and the dew period was longer. Losses were commonly 10 to 15 percent, but in some cases, whole fields were destroyed. Research on blast had been underway for 20 years or since the semi-dwarf, high-nitrogen management system came into existence and set the stage for the blast problem.

The first efforts in control were to eradicate the pathogen in the nursery beds. This failed because even a few escapes to the field could provide the primary inoculum for an epidemic by the end of the season. Also, the peasants used the infected straw in so many different ways, including in their huts, and this provided a source of inoculum. Seed treatments with hot water and Ceresan were used, but by 1979 mercury was prohibited. Some control was obtained by keeping the nursery bed wet since the pathogen could not persist in wet soil.

About 20,000 rice entries were screened for resistance, and from these came "Teptep" and "Carrum." Both varieties had excellent resistance, but probably of the "vertical" type. These varieties became universal sources of resistance to blast. A variety with a Chinese name that meant "narrow green leaf" was released and, because of its excellent resistance and high yield potential, was soon grown on the greatest majority of land in southern China. Within three years (six crops of rice), a race of blast emerged with virulence on the new variety. The variety only lasted from 1973 to 1976.

Experiments were being conducted with a multivariety approach, where one or two different sources of resistance were used, respectively, in the early-, medium-, and late-maturing rice crops. In the year of a pilot test (on 1000 mu using the multivariety approach), blast was extremely serious in the entire province, but only 3 mu were affected in the test, and these 3 mu were planted to the popular susceptible variety. At least five different sources of resistance were studied, but no genetic backup work had been carried out. The potential for use of a single but "multiline" variety was dismal because of the difficulty of getting several different sources of resistance into genotypes that had the same height, maturity date, and other uniform attributes.

Proper management of the high-yielding rice varieties was of special importance. For example, 30 days after transplanting, and when the crop was vegetative, the leaves should be dark green. During heading and seed set, however, the leaves should be more yellow; if still dark green, this greatly favored blast. The flag leaf in particular had to be watched for color and nitrogen applied accordingly, since infection on this plant part was the most damaging.

About 1500 kg of organic manures were applied per mu per year. Another 30 to 40 kg of nitrogen were top-dressed per mu per year. The total amount of nitrogen per year was nearly 1000 kg per hectare. Yields of rice for two crops (one rice season) were as high as 15,000 kg per hectare, but this was the highest. The yield of wheat or other winter crop had to be added to the rice yield to arrive at the total grain yield per hectare per year.

Work was starting in 1979 on multiple resistance in varieties, including resistance to blast, bacterial blight, brown planthopper, rice gall midge and the green rice leafhopper (vector of dwarf and yellow stunt).

Ragged stunt virus, previously known in Indonesia, India, and the Philippines, was found for the first time in the People's Republic of China in Chunghua County [?, sic], Guangdong Province, in May 1979. This was a polyhedral virus particle, 50 to 70 nm in diameter, and was vectored by the brown planthopper. The other virus diseases were currently being controlled by heavy use of phosphate insecticides.

Sheath blight affected a greater total area of rice in the Province than any other disease at the time. It was especially important in the very high yield rice. Two controls used were "reasonable" application of nitrogen and the antibiotic "Jingguong"; that is, Streptomyces hygroscopicus var. jinggagensis. Formerly, organic arsenic was used. The antibiotic was extremely effective when applied one or two times per crop at the flowering stage. The problems were that the antibiotic was not produced in sufficient quantities yet, and the hand method of application was too inefficient so that many fields were sprayed too slowly; that is, too late. Machine application was needed to cover the wide area in the short critical time available. No resistance in the pathogen to the antibiotic had yet turned up in the People's Republic of China, but resistance was known to a similar material, Validamycin A, in Japan.

Guangdong Institute of Entomology, CAS

The Guangdong Institute of Entomology of the Chinese Academy of Sciences (Academia Sinica) was founded in 1958 and had a staff of 167, of which 108 were scientific workers including 39 senior scientists. There were five divisions, as follows.

1. Biological Control Division (or Insect Natural Enemies Research Division). Scientists of this division studied the biology and utilization of natural enemies of rice, citrus and vegetable pests, including production and use of several species; for example, Trichogramma (study of artificial diets for Trichogramma began in 1975), and recently imported exotic natural enemies (including the nematode DD-136 (Neoaplectana carpocapsae) from the USDA, and the predaceous mite Phytoseiulus persimilis from Sweden and England).

2. Insect Ecology Division. Scientists of this division focused their studies on integrated control of rice and citrus pests.

3. Termite Division. Scientists of this division studied the biology and control of termites of South China.

4. Insect Taxonomy Division. Research in this division apparently included taxonomy of predatory mites and at least one group of Coleoptera.

5. Zoology Division. This division was a holdover from a group existing prior to establishment of the institute; division scientists studied the biology and culture of rare and useful animals.

In addition to these divisions, there was a smaller group, the Insect Physiology Group. Research of this group included a study of insect pheromones, specifically that of the rice gall midge, Pachydiplosis [=Orseolia] oryzae (see Appendix 18a).

The institute had a program on control of the citrus red mite (Panonychus citri) with predatory mites (see Appendix 18b and DBC, 1978). Amblyseius mites had been used to control P. citri in mountainous areas in Guangdong Province since initial experiments in 1975 and 1976. Results had been so favorable that use of the method was then being spread to citrus in the hill and plains regions of the Province. There were at least seven species of Amblyseius found associated with P. citri in nature in the area (specifically, the Satian citrus orchard near Guangzhou), including deleoni Muma & Denmark, longispinosus (Evans), largoensis (Muma), newsami (Evans), orientalis Ehara, tsugawai Ehara and ovalis (Evans). A Phytoseiulus sp. mite and four species of coccinellid beetles (Stethorus cantonensis Pang, S. guangxiensis Pang & Mao, S. parapauperculus Pang and S. aptus Kapur) were also found associated with P. citri in the area. Other predators of P. citri in the Satian citrus orchard included: Neuroptera -- Chrysopa boninensis Okamoto, Micromus tumidus Hagen, Ancylopteryx octopunctata (F.); Thysanoptera -- Scolothrips takahashii Priesner, Aleurodothrips fasciapennis (Franklin); Araneida -- Erigonidium gramincolum (Boes & Str.) [=Sundevall], Oedothorax insecticeps Strand.

Citrus-growing hill areas of Guangdong Province were somewhat more arid and had higher temperatures than the mountainous areas, and generally lacked trees other than citrus or any plant ground cover, all of which were detrimental conditions for use of predatory mites. Experiments had been conducted whereby wild flowering plants (Ageratum conyzoides L.) had been heavily planted in citrus groves for ground cover, which increased the humidity and provided a pollen source for food for the predaceous mites. The plants were in close contact with the citrus trees, and provided a good environment for production of large populations of the predatory mites which could readily migrate to the citrus trees to attack citrus red mites. Data were shown which indicated significant increase in Amblyseius populations on citrus in groves planted with Ageratum, as compared with groves without such plants. Papaya trees were also good plants for citrus groves, being not only alternate hosts for the citrus red mite, but also providing habitat and food (the mite and aphids) for arboreal ladybird beetles. Castor bean plants were also a good source of pollen for the predatory mites. If trees other than citrus were located adjacent to citrus groves, there was no need to plant Ageratum in the groves.

The predatory mites were cultured on pollen. At a commune near Guangzhou which cooperated with the experimental work of the institute, three girls could produce 20,000 mites per week. Inoculative releases were made; that is, a one-time release of 500 mites per tree. Data were shown illustrating the decline in citrus red mite populations after such inoculative releases versus check plots with only natural predatory mite populations. This method was being used at the commune level in mountainous areas of Guangdong Province; more study was needed for application in the hill and plains areas.

Populations of citrus scales were low in the area, probably because of a high use of insecticides since the 1960's.

Control of the citrus leafminer, Phyllocnistis citrella, was by use of a selective pesticide (carbaryl-Sevin). Data indicating effectiveness of two concentrations of Sevin were shown; this treatment was not very harmful to the predatory mite populations.

The institute had completed a new motion picture film designed to "popularize" the use of Anastatus sp. for control of the litchi stink bug, Tessaratoma papillosa (see AICD, 1977: 105-106; and Huang et al., 197(4). This work, performed in cooperation with the Department of Biology, Zhongshan University, was being utilized at the institute's cooperating commune near Guangzhou. The Anastatus was being cultured on eggs of the eri silkworm, Philosamia cynthia ricini, at the commune. Parasitized eggs of this species were released for control of T. papillosa, which causes severe fruit drop of the litchi nut crop. (See details of the host's culture under the Trichogramma programs in notes for July 28.) The Anastatus species remained unknown or undescribed (but see Appendix 5).

The institute also conducted studies on conservation of natural enemies of the rice gall midge (Pachydiplosis oryzae) in paddy rice (see Appendix 18c for details). The midge larvae were inside the rice plant so they were difficult to control; thus, integrated control measures were used. There were five native parasites of the midge (as listed in Appendix 18e). Efforts to conserve these in the field included: (1) Field sanitation -- P. oryzae overwinters in plant stems, and, therefore, weeds (especially grasses, which serve as alternate hosts for the midge) and rice stems were removed from paddy fields by hoeing; and (2) judicious use of a selective insecticide (Dipterex) in selective (reduced) areas. In 1977, an experimental area was set aside to study the control of the second generation of the rice gall midge. Seedlings were dipped in Dipterex prior to transplanting; this also provided thrips control. When serious damage to areas of paddy rice became evident (that is, when 20 percent of the plants showed damage), Furadan granules were applied (broadcast). Control of P. oryzae increased by 80 to 90 percent, yield losses decreasing to about 1 percent. Parasitism averaged 60 percent, which was actually lower than in check plots. Furadan was used on 10 percent of the rice-growing area in the province.

The institute's research on the in vitro rearing of Trichogramma (dendrolimi) on artificial diets (see Appendices 18e and 19 for details) had continued the work of J. David Hoffman (USDA, Columbia, Missouri), but had carried this to the point of egg deposition to adult emergence, all in artificial media. The Trichogramma were reared in hanging drops containing egg yolk, milk, hemolymph (of the oak silkworm, which made up 21 to 30 percent of the medium), salt, water and streptomycin (see Appendix 19). However, a

large number of the emergent adults were deformed (wingless and with distended abdomens) though they could still oviposit in eggs of the rice moth (Corcyra cephalonica) and eri silkworm (Philosamia). They were then experimenting with other diet media to overcome the problem of deformed adults. A chart was shown illustrating the development of T. dendrolimi under the artificial diet (Appendix 19). In connection with these studies, a chart listing all species of Trichogramma known in the People's Republic of China was displayed. (See also notes for July 29.)

The Neoaplectana carpocapsae nematode (DD 136), received from S. R. Dutky (USDA, Beltsville, Maryland) in 1978, was being cultured. This was being studied for potential use against Prodenia litura on vegetables, rice stemborers, mosquitoes and termites. Stock culture of DD-136 was maintained on rabbit liver. "Mass" culture was done on P. litura rather than the wax moth, because the latter host took too long to develop in the laboratory.

GUANGZHOU, GUANGDONG PROVINCE, JULY 28

On Saturday, July 28, the delegation visited the Plant Protection Department of the South China Agricultural College and the Plant Protection Institute of the Guangdong Academy of Agricultural Sciences. The following notes are from these visits.

South China Agricultural College, Plant Protection Department

The South China (Hannan) Agricultural College was founded in 1953, and was an amalgamation of the former Colleges of Agriculture of Lingnan University (an extinct church-supported university upon which grounds the current college is located) and of Sun Yat Sen (Zhongshan) University. In 1916, Professor G. W. Groff of Pennsylvania State University had provided leadership in organizing the College of Agriculture and its curriculum using the U.S. Land Grant University system as a model. Many of the professors at the college studied at U.S. universities.

There were eight departments in the college: Plant Protection (including entomology and plant pathology), Agronomy, Horticulture, Forestry, Soils, Sericulture, Agricultural Engineering, and Animal Husbandry and Veterinary Science.

The college had only 1600 students; one fourth of the students were women. It could accommodate 3000, as it once did, except for the fact that it had lost a number of dormitories recently. The college had a total of 700 teachers, including professors, instructors, and teaching assistants. It had a student exchange program with Vietnam and with Egypt. The college could serve the "Third World" in a unique manner because of its specialization in tropical agriculture.

There was a 4-year curriculum based on the semester system, with a long winter and shorter summer vacation, to meet the needs of harvest times. During the fourth year, students went on field trips for at least 3 months to state farms or to communes to get a better appreciation of the real world, and to develop a close practical "feel" for agriculture. Previously, students had to work 2 full days per week on communes. In 1979, only 2 afternoons per week of such work were required. It was noted that this requirement might be reduced further in order to provide more time for fundamental training in the basic sciences. The college was to control entry standards and it planned to raise them.

During the first 2 years, students studied botany, zoology, chemistry, general entomology, insect taxonomy, insect ecology, higher mathematics, physics, biometry and English. The college planned to require the completion of a small research project and a small thesis during the senior year.

One of the department's laboratories was studying methods of controlling citrus pests, mainly by use of natural enemies. A list of the main citrus pests of Guangdong Province was exhibited (see Appendix 20). No scale insects were listed and these were apparently not serious pests in this part of China. In addition to the species listed in Appendix 20, another serious pest was the psyllid *Diaphorina citri*, a vector of the mycoplasma that causes yellow dragon disease of citrus. Infected trees had to be cut down and destroyed; in one farm, for examle, 500,000 citrus trees were cut down because of this disease. Citrus stock could be disinfected of the mycoplasma by heat treatment.

The main task of the laboratory was to develop methods of controlling citrus pests. Pests were not a problem in citrus previously. But in the last decade, due to an "unreasonable use of insecticides, citrus pests have increased in importance." The laboratory was studying the reasons and remedies for such an increase.

In 1973, methods were developed for use of *Trichogramma dendrolimi* for control of citrus leafrollers; (whether *Trichogramma* was still being used in citrus was not learned). More recently, methods for using predatory mites (*Amblyseius deleoni*) for control of citrus red mite (*Panonychus citri*) had been developed and were in use. Charts were exhibited showing the results of release of *A. deleoni* on one tree in a field experiment in a grove of 200 trees. Releases of predatory mites (1000 in each of three releases) were begun when *P. citri* populations reached 50 to 60 per leaf; generally releases were made in September and by October the phytophagous mite populations were decimated. A number of problems remained, however: (1) Predatory mites had humidity requirements that were difficult to meet in many areas of Guangdong Province (some citrus-growing areas were too dry); (2) the predatory mites were quite sensitive to chemicals used on citrus. Also, there were two pests for which no biological controls were yet available -- the citrus psylla, *Diaphorina citri*, that vectored yellow dragon disease of citrus (see above), and the citrus rust mite, *Phyllocoptes* [=*Phyllocoptruta*] *oleivora*. New approaches to biological control were needed. In 1979, the laboratory began new studies, beginning with a survey of natural enemies of citrus pests in the province.

Another laboratory of the department had a sizeable insect collection, though not of "museum size," consisting mainly of rice pests and their natural enemies of Guangdong Province. (A catalog of natural enemies of rice pests of the province was to be published in 1980.)

Cryptolaemus montrouzieri, the ladybird beetle introduced into the People's Republic of China from Australia via the USSR for mealybugs on citrus, was fairly well-established during the period of 1955 to 1964. Then it disappeared and was only then beginning to show up again, being recovered from *Pseudococcus* sp. on *Aleurites moluccana* in the province.

The main objective of this laboratory was to study methods of conservation of natural enemies in paddy rice; the rice planthopper and rice leafroller were primary target pests. These two species were not serious pests 20 years

ago, but were now problems, probably due to unreasonable use of insecticides which had suppressed natural populations of natural enemies in rice. They now tried more selective use of insecticides and Trichogramma releases (though the latter were more practical in North China than in South China, because of poor availability of laboratory hosts in the South).

For the past 4 years, work on rice pests had been done on a small island off the coast of Guangdong Province, which had 2500 mu of paddy rice, and represented a good environment for the study of integrated control.

There had been good progress in the development of life tables of the insect pests. (See Pang et al., 1980, for an insight into these studies.) Charts were exhibited illustrating the life tables for the second generations of Cnaphalocrocis medinalis (the rice leafroller) (see Appendix 21a) and Nilaparvata lugens (the rice planthopper), including lists of their natural enemies.

A third chart showed the effect of different treatments on the life table of C. medinalis: (1) Use of BHC + Parathion (E 1605); (2) use of Trichogramma; and (3) check (see Appendix 21b). Figures showed pest survival rates, and the data indicated the impact of Trichogramma releases on the egg stage, and the impact of the parasites on the larval stages.

For this study, a total of 10,000 Trichogramma per mu was released in three releases at weekly intervals beginning when eggs were first observed in the field. Five point releases were made per mu. Each treatment consisted of 200 mu. Philosamia was used as laboratory host. Releases of parasitized host eggs were made on cards rolled up and placed in bamboo tubes.

Data for this study had been collected each May (at 15 points on 6000 mu) for 4 years (1976 to 1979). Results were to be published after 2 more years of data collection. (See also CRGBCRP, 1974, for results of an early, similar study.)

Stalk borers were the main insect problem on sugarcane in the province, including Argyroploce schistaceana, the most important, and Chilotraea infuscatella, Chilo auricilius, Proceras venosatus (later called "Diatraea" venosatus [=Chilo sacchariphagus stramineelus]), and Scirpophaga nivella. Scarab beetles (that is, sugarcane grubs) were also problems. Though specimens of Perkinsiella saccharicida were in the insect collection, this leafhopper was not much of a problem on sugarcane in Guangdong Province.

(The delegation learned of two locations in the People's Republic of China where postharvest pest problems were studied: Institute for Stored Products Insects of the Zhejiang Province Department of Grain, and the Institute for Stored Grain Pests of the Grain Department of the Ministry of Commerce in Beijing. Scientists studying insect pests of man and animals were located at the Department of Animal Husbandry and Veterinary Science, Beijing Agricultural University, and at the Chinese Academy of Medical Science in Beijing.)

Guangdong Academy of Agricultural Sciences, (GAAS)

The Plant Protection Institute of the Guangdong Provincial Academy of Agricultural Sciences had a total staff of 73 (46 men, 27 women), including 51 engaged in scientific research (including 3 associate research fellows and 23 assistant research fellows), 9 skilled workers, and 3 administrative workers. The institute was responsible for plant protection research for Guangdong Province, and also conducted some research of a national scope. The institute was formerly an experimental farm. In the past 30 years, plant protection studies at this location had been conducted on pests of cereal crops (mainly paddy rice), oil crops, citrus, sugarcane and fiber crops. There had been 37 research accomplishments completed in the 30-year existence of the institute. The major achievements had concerned advances in control of the following pests: rice pests -- rice bacterial blight, sheath blight, yellow dwarf disease, rice stemborers, brown planthopper, rice leafhopper, rice gall midge, rice thrips [?=*Thrips oryzae*] and rice armyworm (*Prodenia litura*); sugarcane pests -- sugarcane borers ("*Diatraea*" *venosata*, *Chilotraea infuscatella*, and *Argyroploce schistaceana*), and integrated pest management systems in sugarcane; oilseed crop pests -- peanut bacterial wilt, peanut rust, peanut leaf spot (*Cercospora*) and armyworm (*Prodenia litura*); and citrus decline. Among the 37 research items completed by the institute, 10 had been recognized at the national level, including their work with *Trichogramma* on sugarcane borers and with *Streptomyces* for sheath blight of rice.

Prior to 1965, the institute worked mainly on pest population dynamics, disease cycles and life cycles of insects. Since then, research had turned to studies on: (1) Development of disease-resistant varieties of crop plants; (2) biological control; and (3) highly effective but low residual type pesticides, with low vertebrate toxicity.

There were nine research areas under study in 1979, as follows: (1-4) Development of rice varieties with multiple resistance against (1) bacterial blight of rice, (2) rice blast, (3) brown planthopper, and (4) rice gall midge; (5) highly effective insecticides with low vertebrate toxicity and short residual life; (6) herbicides for use against weeds in paddy rice; (7) agricultural antibiotics for brown planthopper and bacterial blight of rice (work just beginning); (8) natural enemy resource surveys (just begun); and (9) pesticide residue analysis.

Guangdong Province had an early and long history in biological control and had many units engaged in biological control activities. Stress at the institute had been placed on the utilization of *Trichogramma* for control of sugarcane borers (*Chilotraea*, "*Diatraea*" and *Argyroploce*). (The sugarcane borer larvae fed in the leaf sheath of sugarcane for the first three instars before boring into the stalk.) The species of *Trichogramma* said to be used were *T. "evanescens"* and some *T. dendrolimi* of locally collected origin (from *Chilotraea* and "*Diatraea*"); (but see notes below and for later visit to the Shilong Biological Control Station, July 29). This work was begun in 1952, and it took 13 years before results were ready for practical field application. The work was in association with Zhongshan University, but the institute had stressed techniques for practical field application of *Trichogramma* on the communes, whereas Zhongshan University's stress was on the more basic research aspects.

The first problem investigated at the institute was to determine the best and most economical host for laboratory culture of _Trichogramma_. They first tried eggs of the wheat grain moth, _Sitotroga cerealella_, but soon discarded this because eggs of this species were small, producing too few _Trichogramma_ to be economical, especially since grain was needed for its culture, taking food from the people of the communes; it was also a pest of stored grains. They chose the eri silkworm, _Philosamia cynthia ricini_, as the most ideal laboratory host for this area. The natural host plants of this caterpillar were _Ricinus communis_ L. (castor bean), _Sapium sebiferum_ (L.) Roxb. (wax myrtle), _Manihot utilissima_ Pohl [=_esculenta_ Crantz] (cassava), and _Evodia meliifolia_ (Hance) Bentham. This moth proved to be a more economical laboratory host for _Trichogramma_ for practical use at the commune level. A highly successful artificial diet with high leaf content had recently been developed (but not then published) for this species. The diet for rearing _Philosamia_ larvae consisted of cornmeal, fishmeal, leaves of several plants (see notes for July 29), and ground seaweed (in place of agar). Each female moth was capable of producing 300 to 500 eggs and each egg could produce 20 to 30 _Trichogramma_ adults.

The second problem investigated by the institute was a study of the field ecology of _Trichogramma_ in order to provide information helpful in planning their release program. The relationship of varied temperature, humidity, light and wind conditions to _Trichogramma_ biology and behavior were studied. The optimum field conditions for _T_. "_evanescens_" were found to be temperatures between 20° and 30° C, a RH of 60 to 90 percent, light that "is not too strong," and wind velocities not exceeding 3 m per second. Temperatures influenced the behavior of the _Trichogramma_ wasps as follows: they flew at temperatures of between 20° to 30° C, crawled at temperatures below 20° C, and at temperatures 30° to 45° C were relatively motionless and short-lived (50° C was lethal). Investigations of the field populations showed that there were very few _Trichogramma_ in sugarcane fields during March to May. Since "dead heart" of sugarcane (caused by stalk borers) occurred widely at that time, it was necessary to add (release) _Trichogramma_ during that period to increase field parasitism.

The third problem studied at the institute was _Trichogramma_ release technology. Seven years of basic research on the field ecology and biology of the pests and of the wasps were required to optimize releases. Releases were begun in mid-February. Releases were then made eight or nine times at 15- to 20-day intervals, with a total of 150,000 to 200,000 wasps released per ha each release. No releases were made after August, since borer populations declined by that time. (Cane harvest was in November-December.) The effective radius for point release was 17 m, but maximum parasitism occurred in a 10-m radius. Considerable research was conducted on the release container. Matchboxes were found to be inappropriate. Therefore they used broad tree leaves which could be rolled into tubes and attached to the cane plant. After a successful pilot test this method was implemented. (Note: At the Shilong Biological Control Station, the cane leaf itself was folded over the card of parasitized eggs and tied in that position.) Since 1965, the institute had been studying mechanization of _Trichogramma_ releases, the results of which were seen at the Shilong Biological Control Station the following day. Sugarcane yields had increased 10 to 15 percent (6 to 10 tons of cane per ha) as a result of the _Trichogramma_ release programs. Normal yield was cited at 75 tons per ha. (Plant density was noted to be 6000 to 7000 sugarcane plants per mu.) During these discussions, it was also noted that field sanitation was important in controlling sugarcane borers.

The institute was embarking on a new line of study -- means for widening the use of natural enemies for pest control, and was interested in accumulating more literature and other information in this regard.

In the past, the institute worked with the "Cuban fly," Lixophaga diatraeae, for control of sugarcane borers. The species was introduced from Cuba in 1958 [?], and was cultured (on wax moth larvae fed on their natural diet -- beeswax and pollen) and released for 5 or 6 years [1958 to 1963?]. Results were not promising (that is, low field parasitism following release) and the species failed to become established in the area. It was noted that Apanteles flavipes was not found as a borer parasite in this area.

This institute was the first to field test and demonstrate the effectiveness of the Streptomyces hygroscopicus var. jingaggensis, found initially in Shanghai, for sheath blight of rice. This antibiotic was used in five provinces of the People's Republic of China by 1979, on a total of about 3 million mu. There was at least one fermentation plant in Guangdong Province producing it, and other such plants were scattered throughout the other four provinces using this antibiotic. No data were available on total output. After 5 years of research on the preparation, 30,000 mu were treated in the Province. Validimycin A, a Japanese product, was somewhat similar to the jingaggensis. However, the Streptomyces species was different from the one used in Guangdong Province. Other microbial preparations killed armyworms, planthoppers and rice pathogens in the province.

The institute had no research on insect pathogens or insect sex attractants. However, there were two areas of research on herbicides. The following list of weeds were considered important pests in the province: Cyperus rotundus L., Polygonum hydropiper L., Fimbristylis miliacea (L.) Vahl, Jussiaea repens L. [?=Ludwigia sp.], Echinochloa crusgalli (L.) Beauv., Leersia hexandra Swartz, Arthraxon hispidus (Thunb.) Mak., Cynodon dactylon (L.) Pers., Digitaria sanguinalis (L.) Scop., Paspalum scrobiculatum L., and Sagittaria sagittifolia leucopetala (Miq.) Hartog. Weed control was accomplished by use of NIP, MCPA and DCPA. Recently they turned to Saturn obtained from Japan to control Echinochloa crusgalli.

In May 1979 the institute had found the first record of the ragged stunt disease virus in the People's Republic of China, in Chunghua [?, sic] County of Guangdong Province. This disease was found in the Philippines and elsewhere in Southeast Asia.

HUIYANG REGION, GUANGDONG PROVINCE, JULY 29

On Sunday, July 29, the delegation visited the Shilong Biological Control Experiment Station in Yunde County. The following notes on that visit are also the final notes on the U.S. scientists' visit to People's Republic of China.

Shilong Biological Control Experiment Station, Yunde County, Huiyang Region

The Shilong Biological Control Experiment Station was established in 1969. It was formerly a small experimental farm, but had greatly enlarged, and had a staff of 30 persons in 1979. The station was under contract with the state to produce and supply Anastatus for control of the litchi stink bug, and Trichogramma for control of sugarcane borers for four counties (15 communes) of Guangdong Province. The three major sugarcane pests were "Diatraea" venosata (Walker)(=Proceras venosatus (Walker) [=Chilo sacchariphagus stramineelus (Caradja)]), the spotted, or striped, sugarcane borer; Argyroploce schistaceana Snellen, the gray, or white, sugarcane borer; and Chilotraea infuscatella (Snellen), the yellow sugarcane borer.

The Trichogramma were sold to the communes at the rate of 0.50 yuan per mu per year (for a total of eight releases). The station had contracts to supply the communes with the wasps, but the communes had to make the releases. The station also provided stocks of Trichogramma for culture in other areas of the province. Station personnel also trained commune workers in Trichogramma culture techniques, and gave demonstrations on the use of Trichogramma and other integrated control measures to various communes in the area, in this way enlarging the area of Trichogramma use.

The number of Trichogramma produced at the station ranged from 7 to 8 billion per year in 1979. The area on which Trichogramma was released (normally eight times a year) gradually increased from 30,000 mu in 1976, 40,000 in 1977, 55,000 in 1978, to 65,000 mu in 1979. Generally, parasitized host eggs were released at five points per mu, 200 host eggs per release.

The main Trichogramma species produced were T. dendrolimi, with some T. confusum and T. "evanescens" being used. Cultures were newly established each year from stocks collected from sugarcane borers locally. Trichogramma confusum was collected from "Diatraea" venosata egg masses, whereas a mixture of T. dendrolimi and T. "evanescens" were collected from Argyroploce schistaceana and Chilotraea infuscatella. Identifications of the species were made by the South China Agricultural College in Guangzhou and the Zoological Institute in Beijing (see Pang and Chen, 1974). (New identifications were not necessarily made every year when new cultures were established.)

(Prior to 1975, only 12 species of Trichogramma were known in the People's Republic of China; there were 18 in 1979, as follows: dendrolimi, confusum, evanescens, japonicum, embryophagum, ostriniae, chilonis, closterae, ivelae, leucaniae, fasciatum, minutum, lingulatum, poliae, raoi, sericini, euproctidis, and "polychrosis" [a manuscript name]. See Pang and Chen, 1974.

The main hosts for Trichogramma culture used at the station were the eri silkworm, Philosamia cynthia ricini, and the oak silkworm, Antheraea pernyi. The latter were imported by train as cocoons from North China during the winter months. Philosamia was called the main laboratory host, though the station apparently often used the oak silkworm eggs. An artificial diet was developed for Philosamia in cooperation with the Guangdong Academy of Agricultural Sciences and was being refined at the station. Chloramphenicol was added to the artificial diet for Philosamia; Philosamia was also reared on leaves of Evodia meliifolia, castor beans, and cassava. (See also notes on the academy's Plant Protection Institute, July 28.)

In 1976, study of the mechanization of *Trichogramma* production was begun, in cooperation with the Guangdong Academy's Plant Protection Institute. In 2 years, machinery was developed that had increased production of *Trichogramma* 10-fold over the old hand operation methods.

The Station had the following facilities for the production of *Trichogramma*.

1. A machine, with opposable stiff bristles, had been developed at the Station for crushing adult female oak silkworms; the debris was flushed out and the eggs were collected in water; these were centrifuged dry. Another machine had been developed for automatically gluing the eggs onto rolls of paper (using "peach gum") for exposure to *Trichogramma*, and later placement in the field.

2. *Trichogramma* "stinging" rooms. The station used several methods for parasitizing host eggs were demonstrated including: (a) A dark room exposed to natural light only on one side, in which host eggs were exposed to *Trichogramma* (*dendrolimi*) for 8 hours; enough *Trichogramma* could be produced in this room for releases on 10,000 mu per day (at the rate of one egg sheet per 10 mu); (b) host eggs glued onto paper rolls were loosely rolled up with small numbers of laboratory-parasitized eggs from which *Trichogramma* were emerging; the ends of the rolls were covered by black cloth "bags"; exposure time was again 8 hours; each roll contained about 3.5 kg of oak silkworm eggs (1 kg was enough for releases on 500 mu); (c) the rolls of paper with host eggs were also placed on a rotating cylinder with fluorescent lights at the ends, under which were placed emerging *Trichogramma*; only those individuals with positive phototaxis effectively parasitized the new host eggs in this "wheel of light."

3. Measurement of rate of parasitism of laboratory-parasitized host eggs was done with a densitometer, with 95 percent accuracy. Average laboratory parasitism ranged from 70 to 90 percent.

The station collected host eggs from the field to obtain *Trichogramma* to provide stock for renewal of laboratory cultures.

There were also a laboratory culture of *Anastatus* sp. for use in the control of the litchi stink bug (oak silkworm eggs were used as laboratory hosts), and cultures of *Ooencyrtus corbetti*, another parasite of litchi stink bug eggs.

A 5-year old citrus grove located near the station had begun to produce in its third year. It was planted in two parallel rows on 6- to 7-meter-wide raised beds. The tops of the beds were about 1.5 meters above the water in the trenches. The primary citrus pests of the area were: *Phyllocnistis citrella* (citrus leafminer), "*Phyllocoptes*" *oleivorus* (citrus rust mite), *Pseudococcus* spp. (mealybugs), *Icerya purchasi* (cottonycushion scale), *Chrysomphalus ficus* [=*aonidum*] (a red scale), and *Oraesia emarginata* and *O. excavata* (noctuid moths). Little insecticide was used in the grove; those chemicals used were Dipterex (=Dylox) (mainly for *P. citrella*), and a tobacco leaf extract.

Also located near the station was a sugarcane field in which the oak silkworm eggs with Trichogramma were placed in bent-over leaves that were tied with a string. Parasitized eggs were placed at five points per mu. In the sugarcane stand visited, 5 of 13 stems examined were bored, apparently despite Trichogramma releases there. The stand consisted of sugarcane variety 423, which was developed in Guangdong Province.

Rice blast, caused by Piricularia oryzae, was controlled by rotating rice varieties with five or six different genotypes for resistance. This approach was pilot tested and implemented broadly. Typical rotations for Guangdong were (a) sweet potato-rice-wheat (or green manure), (b) rice-rice-rice, and (c) rice-peanut-wheat. One metric ton (2200 lbs) of rice per mu was expected that year in Guangdong Province. On July 26, a 33-mu rice field in the area was harvested and it produced 750 kg per mu. (There was to be one additional crop that year.) The previous mean was 350 kg/mu. Previous maximum yield was greater than one ton per mu. Wheat (one crop per year) yields amounted to 70 to 80 kg per mu in the Province.

POSTSCRIPT

The Chinese delegation on Biological Control visited the United States from August 17 to September 15, 1979. This delegation consisted of the following members: Qiu Shibang, CAAS, Beijing, delegation Leader; Zhao Xiufu, Fujian Agricultural College; Jin Liang, Hubei Province Agricultural Bureau; Ceng Zhaohui and Zhang Jinhui (interpreter), Ministry of Agriculture, Beijing; Liu Zhicheng, Guangdong Academy of Agricultural Sciences; and He Junhua, Zhejiang Agricultural University.

During or subsequent to their visit (see Chiang, 1980, for details of their itinerary), Chinese delegation members presented a number of books and reprints to U.S. delegation members, and a culture of the antibiotic Streptomyces hygroscopicus var. jinggagensis (see Appendix 2). During their travels in the United States (see Chiang, 1980), the Chinese delegation received live biological control material from U.S. scientists, or material was later sent for use in biological control research programs in the People's Republic of China (see Appendix 22.)

As a result of the knowledge gained and contacts made during this exchange of biological control delegations between the two countries, proposals were developed by both sides for further exchanges and cooperative studies under the biological control exchange agreement. Of the six specific proposals for implementation in 1980 that were made by the U.S. delegation, four were selected and approved by both sides. Thus, in 1980, three teams of U.S. biological control scientists visited the People's Republic of China, and one team of People's Republic of China biological control specialists visited the United States. The U.S. teams consisted of (1) a three-man team on "Biological Control of Stemborers in Corn, Sugarcane and Rice," led by A. N. Sparks, of USDA's Southern Grain Insects Research Laboratory, Tifton, Georgia, that visited China in July, 1980; (2) a two-man team on "Survey and Taxonomic Study of Natural Enemies of Crop Pests," led by P. M. Marsh, Chief of USDA's Systematic Entomology Laboratory, Beltsville, Maryland, that visited China in September, 1980; and (3) Paul DeBach, University of California, Riverside, who formed a one-man "team" on "Parasites and Predators of Pests of Citrus, Deciduous Fruits and Field Crops," visiting China in September and October,

1980. The PRC team on "Introduction of Biological Control Agents" consisted of two scientists and an interpreter, led by Bao Jianzhang, Deputy Chief of the Biological Control Laboratory, CAAS, Beijing. The primary purpose of this visit, which took place in August, 1980, was to study U.S. biological control quarantine facilities and procedures.

Also in 1980, arrangements were made, and permits were obtained, to begin exchanging biological control agents between the two countries. Some agents were hand carried by the visiting U.S. and PRC teams and others in 1980 (see Appendix 23). Also, proposals for 1981 for further biological control exchanges and cooperative research were solicited and evaluated by the U.S. Biological Control Delegation, functioning as a work panel on biological control of the International Science and Education Council.

And, finally, at the second meeting of the US-PRC Joint Working Group on Agricultural Cooperation in Science and Technology, held in Washington, D.C., December 1-3, 1980, both sides identified priority areas and agreed to implement a total of 24 exchanges in 1981. Those in areas related to biological control included from the United States, teams dealing with insect taxonomy, biological control of soybean pests, integrated pest management of forest pests, and entomogenous microorganisms, and one PRC team concerning entomogenous microorganisms.

Thus, by the end of 1980, a firm foundation was laid for close cooperation between U.S. and PRC scientists in biological control to include long- and short-term cooperative research projects, further scientist and information exchanges, and exchange of biological control agents for the mutual benefit of plant protection and agricultural research in both countries.

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LIST OF APPENDICES
(with sources indicated as appropriate)

1. Name List of Biological Control Scientists in the Chinese Agricultural Research Institutes and Agricultural Colleges (1979). Received from the PRC Biological Control Delegation at Beltsville, Maryland, August 20, 1979. (The list does not include scientists of the Chinese Academy of Sciences and affiliated institutes.)

2. Live Biological Control Material Obtained by the United States from the Peoples Republic of China in 1979.

3. Tobacco Insects of Henan Province.

4. Notes on the Use of Microbials against some Insect Pests in the People's Republic of China.

5. Arthropod Specimens Received or Collected for Identification by the U.S. Biological Control Delegation, 1979, with Determinations by U.S. Taxonomists.

6. Preliminary List of Biological Materials Available in Chinese Institutions (1979). Received from the Biological Control Laboratory, Chinese Academy of Agricultural Sciences, Beijing, July 10, 1979.

7. PRC Plant Importation Quarantine List, Issued by the Ministry of Agriculture, September, 1966. List of Organisms Prohibited Entry into the People's Republic of China presented to the U.S. Delegation on Biological Control by the PRC Ministry of Agriculture, July 10, 1979.

8. List of Insect, Mite, and Tick Taxonomists, and their Specialities, of PRC Research Institutes Visited in the People's Republic of China by the U.S. Biological Control Delegation. Developed from lists received from the Zoological Institute, Beijing, and Shanghai Institute of Entomology, and discussions at other locations visited.

9. Forest Insect Pests of Jilin Province. From a list received from the Jilin Forestry Research Institute, Changchun, July 14, 1979.

10. List of Insects Observed at Light Traps in Wu County, Suzhou Region, Jiangsu Province. Received from the Plant Protection Division, Suzhou Region Agricultural Bureau, July 17, 1979.

11. Rice Pests of Changshu County, Suzhou Region, Jiangsu Province. List received from the Changshu County Pest Monitoring and Forecasting Station, July 18, 1979.

12. Major Crop Pests of Taicang County, Suzhou Region, Jiangsu Province. List displayed at the Taicang County Pest Monitoring and Forecasting Station, July 18, 1979.

13. Citrus Pests of Suzhou Region, Jiangsu Province, and Insecticides Used in the Area. List received from Dong Ting Commune, July 19, 1979.

14. Important Natural Enemies of Cotton Pests in the Shanghai Area. List received from the Shanghai Academy of Agricultural Sciences, July 21, 1979.

15. Antibiotics Used for Plant Disease Control in China, 1979.

16. Distinction between "Aphicide"-producing Fungus and Streptomyces griseolus Waksman. Table displayed at Zhejiang Academy of Agricultural Sciences, July 23, 1979. Translation by H. C. Chiang.

17. Major Insects and Diseases and their Natural Enemies of "Red-in-the-East" Commune, Xiaoshan County, Zhejiang Province.

18. Abstracts of Research Areas of the Guangdong Institute of Entomology, 1979. Handed to U.S. Delegation members during visit to the institute in Guangzhou, July 27, 1979.
    a. Studies on the Sex Pheromone of the Rice Gall Midge, Pachydiplosis (Orseolia) oryzae.
    b. Studies on the Integrated Control of the Citrus Red Mite with the Predaceous Mite as a Principal Controlling Agent.
    c. Studies on Natural Enemies of the Rice Gall Midge.
    d. A List of Natural Enemies of Rice Pests in Guangdong Province.
    e. Rearing of Trichogramma dendrolimi in Artificial Diets.
    f. Utilizing Bracon greenei Ashmead as a Means to Control Eublemma amabalis Moore in the Forests of Lac Production.
    g. Culicide Effect of a New Species of Streptomyces.
    h. The Migration Zones of the Armyworm (Mythimna separata) and the Mathematical Model of its Distribution.

19. The Development of Trichogramma dendrolimi in Artificial Diet Drops. Chart displayed at the Guangdong Institute of Entomology, Guangzhou, during the visit of the U.S. Delegation July 27, 1979.

20. Main Citrus Pests of Guangdong Province. List displayed at South China Agricultural College, Guangzhou, during the visit of the U.S. Delegation, July 28, 1979.

21. Charts Displayed at the South China Agricultural College, Guangzhou, during the visit of the U.S. Delegation, July 28, 1979.
    a. Life Table for Second Generation of Rice Leafroller, Cnaphalocrocis medinalis, in Guangdong Province.
    b. The Effect of Different Treatments on the Life Table of Cnaphalocrocis medinalis.

22. Live Biological Control Material Obtained by the People's Republic of China from the United States in 1979. List prepared with the assistance of Dr. Qiu Shibang, Chief, Biological Control Laboratory, CAAS, Beijing, and Leader of the People's Republic of China Biological Control Delegation, 1979.

23. Biological Control Agents Exchanged Between the United States and the People's Republic of China in 1980. List prepared with the assistance of Dr. Qiu Shibang, Chief, Biological Control Laboratory, CAAS, Dr. P. DeBach, University of California, Riverside, California, and Dr. C. W. McCoy, University of Florida, Lake Alfred, Florida.

24. Procedures for Importation of Biological Control Material into the People's Republic of China, as discussed by the PRC Ministry of Agriculture, Beijing, July 10, 1979.

25. Detailed Itinerary of the U.S. Biological Control Delegation, with Names of Persons Met.

NAME LIST OF BIOLOGICAL CONTROL SCIENTISTS IN THE CHINESE AGRICULTURAL RESEARCH INSTITUTES AND AGRICULTURAL COLLEGES (1979)

Chinese Academy of Agricultural Sciences (CAAS), Beijing

Qiu Shibang	Biological control of agricultural pests
Tian Yuqi	Biological control of agricultural pests
Chen Tingwei	Microbial pathogens for insect control
Ye Zhengchu	Biological control of insect pests

Beijing Agricultural University, Beijing

Yang Jikun	Taxonomic research on Chrysopidae and other beneficial insects
Yan Yuhua	Biological control of vegetable insects
Cai Ninghua	Biological control of vegetable insects

Beijing Academy of Agricultural Sciences, Beijing

Zhang Zhili	Control of corn borer with *Trichogramma*
Huang Rongsheng	Control of corn borer with *Trichogramma*

Chinese Academy of Forestry Sciences, Beijing

Xiao Gangrou	Biological control of forest insects
Chen Shangjie	Microbial pathogens for forest insect control
Wang Zhixian	Microbial pathogens for forest insect control

Institute of Cotton Research, CAAS, Anyang, Henan Province

Fang Changyuan	Biological control of cotton insects

Institute of Pomological Research, CAAS, Zhengzhou, Henan Province

Qiu Tongduo	Biological control of fruit insects
Li Yan	Biological control of fruit insects

Institute of Citrus Research, CAAS, Chongqing, Sichuan Province

Chang Gecheng	Biological control of citrus insects

Heilongjiang Institute of Agricultural Research, Jiamusi, Heilongjiang Province

Ma Huaiyi	*Trichogramma*

Jilin Academy of Agricultural Sciences, Gongzhuling, Jilin Province

Wang Chenglun	Research on *Trichogramma*
Xu Qingfeng	Research on *Beauveria bassiana*

Jilin Institute of Forestry Sciences, Changchun, Jilin Province

Yu Enyu	Biological control of forest insects

Shenyang Agricultural College, Shenyang, Liaoning Province

Zhang Jing	Taxonomy and use of *Trichogramma*

Shandong Academy of Agricultural Sciences, Jinan, Shandong Province

Feng Jianguo	*Trichogramma*
Xie Sibi	Research on *Bacillus popilliae*

Shanxi Academy of Agricultural Sciences, Taiyuan, Shanxi Province

Zhou Yunning	*Trichogramma*

Shanxi Institute of Cotton Research, Yuncheng, Shanxi Province

Wang Fucheng	Biological control of cotton insects

Hebei Institute of Pomological Research, Changli, Hebei Province

Mo Jugao	Biological control of fruit insects

Hebei Institute of Plant Protection, Soil and Fertilizer, Baoding, Hebei Province

Nan Liuzhu	*Trichogramma*

Baiquan Agricultural School, Hui County, Henan Province

Li Shulu	*Trichogramma*

Northwestern Agricultural College, Wugong, Shaanxi Province

Wei Jianhua	Biological control of aphids

Institute of Plant Protection, Shaanxi Academy of Agricultural Sciences, Wugong, Shaanxi Province

Zhang Xiaoliang	Aphid control with microbial pathogens

Shanghai Academy of Agricultural Sciences, Shanghai

Zhang Xuefang	Biological control of cotton insects

Zhejiang Agricultural University, Hangzhou, Zhejiang Province

Zhu Ruzuo	Taxonomic research on beneficial insects
Li Xueliu	Taxonomy of Chalcidoidea and biological control of citrus insects
He Junhua	Taxonomy of Ichneumonoidea and biological control of rice insects
Hu Cui	Biological control of vegetable and tea insects

Zhejiang Institute of Forestry Research, [Hangzhou(?), Zhejiang Province]

Wu Juwen	Biological control of forest insects

Hubei Academy of Agricultural Sciences, Wuhan, Hubei Province

He Benji	Biological control of cotton insects
Peng Zhongyun	Research on *Bacillus thuringiensis*
Wen Jiayu	Biological control of rice insects

Hunan Agricultural College, Changsha, Hunan Province

Chen Changming	Biological control of rice insects

Hunan Institute of Forestry Research, Changsha, Hunan Province

Peng Jianwen	Biological control of forest insects

Sichuan Academy of Agricultural Sciences, Chengdu, Sichuan Province

Chen Fangjie	Biological control of citrus insects
Zhang Ruozhi	Biological control of rice insects

Southwestern Agricultural College, Chongqing, Sichuan Province

Li Longshu	Taxonomic study of Acarina

Fujian Agricultural College, Shaxian, Fujian Province

Zhao Xiufu	Taxonomic research on Ichneumonoidea and biological control of rice insects
Chen Jiahua	Taxonomic research on Aphidiidae, and biological control of vegetable insects
Huang Bangkan	Taxonomic research on Coccinellidae, and biological control of fruit insects

Guangdong Academy of Agricultural Sciences, Guangzhou, Guangdong Province

Liu Zhicheng	Research on *Trichogramma* and biological control of sugarcane insects

South China Agricultural College, Guangzhou, Guangdong Province

Pang Xiongfei	Taxonomic research on Coccinellidae and Trichogramatidae
Chen Shoujian	Biological control of citrus insects

Guangxi Academy of Agricultural Sciences, Nanning, Guangxi Province

Deng Guorong	Biological control of rice insects

Guangxi Agricultural College, Nanning, Guangxi Province

Jin Mengxiao	Research on Trichogramma and biological control of sugarcane insects

Yunnan Academy of Agricultural Sciences, Kunming, Yunnan Province

Wang Luzhe	Biological control of rice insects

LIVE BIOLOGICAL CONTROL MATERIAL OBTAINED BY THE UNITED STATES FROM THE PEOPLE'S REPUBLIC OF CHINA IN 1979[1]/

A. Entomogenous Microorganisms [2]/

1. Nuclear polyhedrosis virus (NPV) ex *Euproctis similis*

   Received July 1979 (US/PRC-79-1) by the U.S. Delegation in the People's Republic of China, from the Shanghai Institute of Entomology, CAS, Shanghai. Deposited September 1979 in USDA Insect Pathology Laboratory, Beltsville, Maryland.

2. NPV ex *Euproctis pseudoconspersa*

   Received July 1979 (US/PRC-79-7) by the U.S. Delegation in the People's Republic of China, from the Tea Research Institute, CAAS, Hangzhou. Deposited September 1979 in USDA Insect Pathology Laboratory, Beltsville, Maryland.

3. NPV ex *Prodenia* [= *Spodoptera*] *litura*

   Received July 1979 (US/PRC-79-4) by the U.S. Delegation in the People's Republic of China, from the Institute of Zoology, CAS, Beijing. Deposited September 1979 in USDA Insect Pathology Laboratory, Beltsville, Maryland.

4. NPV ex *Heliothis armigera* [= *H. armiger*]

   Received July 1979 (US/PRC-79-5) by the U.S. Delegation in the People's Republic of China, from the Biology Department, Fudan University, Shanghai. Deposited September 1979 in USDA Insect Pathology Laboratory, Beltsville, Maryland. (Small portion also at Pennsylvania State University.)

5. NPV ex *Heliothis armigera*

   Received July 1979 (US/PRC-79-6) by the U.S. Delegation in the People's Republic of China, from Gan Hu National Farm, Tianmen (Tien Men) County, Hubei Province (via Dr. J. M. Franz). Deposited September 1979 in USDA Insect Pathology Laboratory, Beltsville, Maryland. (Small portion also at Pennsylvania State University.)

6. Granulosis virus (GV) ex *Pieris* [= *Artogeia*] *rapae*

   Received July 1979 (US/PRC-79-2) by the U.S. Delegation in the People's Republic of China, from the Institute of Zoology, CAS, Beijing. Deposited September 1979 in USDA Insect Pathology Laboratory, Beltsville, Maryland.

See footnotes at end of appendix.

7. GV ex *Pieris rapae*

Received July 1979 (US/PRC-79-3) by the U.S. Delegation in the People's Republic of China, from the Plant Protection Department, Zhejiang Agricultural University, Hangzhou. Deposited September 1979 in USDA Insect Pathology Laboratory, Beltsville, Maryland.

8. *Beauveria bassiana* (Fungi imperfecti) 3/

Received July 1979 (US/PRC-79-8) by the U.S. Delegation in the People's Republic of China, from Bai Mao Commune, Changshu County, Suzhou Region, Jiangsu Province. Deposited August 1979 in USDA Insect Pathology Research Unit, Ithaca, New York. 3/

B. Entomophagous Arthropods

None.

C. Antagonists, Antibiotics, etc., for Control of Plant Pathogens

1. *Endothia parasitica* (Chestnut blight fungus), possibly hypovirulent strain 4/

Collected July 1979 (USA/PRC-79-9) by the U.S. Delegation in Wu County, Suzhou Region, Jiangsu Province. Passed through USDA quarantine, Beltsville, Maryland, and shipped August 3, 1979 (BIIL(PPQ)-79-16) to Connecticut Agricultural Experimental Station (J. E. Elliston), New Haven, Connecticut, for study. 4/

2. *Streptomyces* sp. (Actinomycete)

Received July 1979 (USA/PRC-79-10) by the U.S. Delegation in the People's Republic of China, July 1979, from Prof. Yin Shenyun, Agricultural Antibiotics Laboratory, CAAS, Beijing; originally ex soil, Beijing Municipality, 1955. Deposited August 1979 at USDA Regional Cereal Disease Laboratory, Pullman, Washington; for study as potential biocontrol agent for soilborne diseases.

3. *Streptomyces hygroscopicus* var. *jinggagensis* (Actinomycete)

Received August 1979 (USA/PRC-79-11) by J. R. Coulson from the People's Republic of China Delegation (Ceng Zhaohui) in the United States; originally ex soil at Jinggong Mtn., Shaanxi Province, 1973. Portions sent October 1979 to USDA Soilborne Disease Laboratory, Beltsville, Maryland, and USDA Regional Cereal Disease Laboratory, Pullman, Washington, for study as potential biocontrol agent for *Rhizoctonia* sheath blight and related disease organisms.

1/ Nonbiological control material brought back by the U.S. Delegation (R. J. Cook) from the People's Republic of China in July 1979 included the following plant pathogens for research purposes:

a. In pure cultures

(1) Fusarium graminearum, Jiangsu Prov. (NF3447)
(2) F. graminearum, Jiangsu Prov. (NF3448)
(3) F. avenaceum, Jiangsu Prov. (NF3434)
(4) F. avenaceum, Jiangsu Prov. (NF3435)
(5) F. culmorum, Shaanxi Prov. (NF4267)
(6) F. culmorum, Shaanxi Prov. (NF4268)
(7) F. graminearum, Guangdong Prov.
(8) F. graminearum, Zhejiang Prov. (AAS)
(9) F. graminearum, Zhejiang Prov. (516-1)
(10) F. graminearum, Zhejiang Prov. (517-1)
(11) F. nivale, Zhejiang Prov. (104-1)

b. On plant material

(1) Gibberella stage on wheat stems - Shanghai
(2) Fusarium stage on wheat spikes - Shanghai
(3) Fusarium stage on wheat spikes - Suzhou Region
(4) Gibberella stage on corn stalks - Jilin Province

2/ Does not include material exchanged outside US/PRC biocontrol exchange agreement, including eight cultures of Bacillus thuringiensis received in recent years from PRC scientists by Dr. H. T. Dulmage, USDA Cotton Insects Research, Brownsville, Texas.

3/ No Beauveria was found in this material at Ithaca. Only contaminant saprobic fungi were identified at Ithaca, including Penicillium and Scopulariopsis brevicaulis Bainier. A culture of the latter species is being held in liquid nitrogen at Ithaca as RS-385.

4/ Several different compatability groups were obtained from cultures of this material at New Haven; all were normally virulent.

TOBACCO INSECTS OF HENAN PROVINCE

Major Tobacco Pests

1. *Gryllotalpa unispina* Saussure
   Gryllotalpa africana Palisot de Beauvois

2. *Pleonomus canaliulatus* (Faldermann)
   Agriotes fuscicollis Miwa

3. *Agrotis ypsilon* (Rott.) [= *A. ipsilon* Hufnagle]

4. *Myzus persicae* (Sulzer)

5. *Heliothis assulta* (Guenee)

Other Tobacco Pests

1. *Sympiezomias lewisi* Roelofs

2. *Dolycoris baccharum* (L.)

3. *Gnorimoschema operculella* (Zeller) [= *Phthorimaea operculella* (Zeller)]

Beneficial Insects

1. *Chrysopa septempunctata* Wesmael
   Chrysopa formosa Brauer
   Chrysopa sinica Tjeder

2. *Sphaerophoria* sp.
   Metasyphrus corollae (F.), etc.

3. *Nabis sinoferus* Hsiao

4. *Lysiphlebus* sp.

Appendix 4

NOTES ON THE USE OF MICROBIALS AGAINST SOME INSECT PESTS IN THE PRC

	Organism used and target pest	Province (Date) of use
1.	*Bacillus thuringiensis* to control corn borer	Hebei (1953)
2.	*Beauveria bassiana* to control soybean pod borer	Jilin (1954)
3.	*Beauveria bassiana* to control sweet potato weevil	Fujian (1956)
4.	*Entomophthora* sp. to control yellow rice borer, etc.	Yunnan (1959)
5.	*Beauveria bassiana* to control pine caterpillars	Fujian, Guangdong, Guangxi (1958)
6.	*Metarrhizium anisopliae* to control beet weevil and *Agrotis segetum*	Nei Monggol Zizhiqu (Inner Mongolia) (1960)
7.	*Bacillus thuringiensis* to control apple ermine moth	Heilongjiang (1961)
8.	*Bacillus thuringiensis* to control yellow rice borer, pink bollworm, *Choristoneura murinana*, corn borer, skipper butterfly, etc.	Hubei (1961)
9.	*Bacillus thuringiensis* var. *sotto* and var. *dendrolimus* to control pine caterpillars	Hubei (1961)
10.	*Beauveria bassiana* to control hoppers	Fujian (1961)
11.	*Beauveria bassiana* to control beet weevil and *Agrotis segetum*	Xinjiang (1964)
12.	"*Bacillus thuringiensis*" [or *Beauveria bassiana*?], to control budworm, cabbageworm and corn borer	Sichuan (1962)
13.	*Beauveria bassiana* to control beet weevil and *Agrotis segetum*	Xinjiang (1963)
14.	"*Bacillus thuringiensis*" [or *Beauveria bassiana*?] to control diamond bollworm	Hubei (1961)
15.	*Bacillus thuringiensis* and *Beauveria bassiana* to control tea worms	Gueizhou (1964)
16.	*Beauveria bassiana* to control cabbageworm	Fujian (1965)
17.	Fungus and bacteriological materials to control yellow rice borer, skipper butterfly, armyworm, *Choristoneura murinana*, cabbageworm, and other Lepidoptera, and rice leafhopper, planthopper, etc.	All cities (1968)

ARTHROPOD SPECIMENS[1/] RECEIVED OR COLLECTED IN THE PEOPLE'S REPUBLIC OF CHINA FOR IDENTIFCATION BY THE U.S. BIOLOGICAL CONTROL DELEGATION, 1979, WITH DETERMINATIONS BY U.S. TAXONOMISTS

A. Specimens of Ostrinia (corn borer)[2/]

1. Four unpinned adults from a laboratory culture of the Institute for Application of Atomic Energy in Agriculture, CAAS, Beijing, received July 7, 1979. Origin of the laboratory culture was from material collected in Liaoning Province.

2. Nine pinned and labeled adults from light trap collections, 1957 to 1965, supposedly from Beijing Municipality (labels in Chinese). Received from Beijing Agricultural University, Beijing, July 10, 1979.

3. Ten pinned, unlabeled adults, and uncounted number of unpinned adults laboratory-reared from overwintered larvae collected in the vicinity of Changchun, Jilin Province. Received from the Jiling Agricultural Bureau, Division of Plant Protection, Changchun, July 14, 1979.

4. Three adults, one larva, one pupa and eggs in a glass display case, said to be collected in the vicinity of Gongzhuling, Jilin Province (label in Chinese). Received from Gongzhuling Plant Protection Institute, at Changchun, July 14, 1979.

5. Six pinned, unlabeled adults from a laboratory culture of the Shanghai Academy of Agricultural Sciences, received July 21, 1979. Origin of the laboratory culture was from material collected in Shanghai Municipality.

6. Ten pinned and labeled adults said to be from collections in Shanghai Municipality, 1958 to 1975 (labels in Chinese). Received from Shanghai Institute of Entomology, CAS, July 21, 1979.

7. Six pinned and labeled adults said to be from collections in Guangdong Province, 1957 (labels in Chinese). Received from Guangdong Plant Protection Institute, July 28, 1979.

B. Specimens of Trichogramma[3/]

1. "T. dendrolimi" adults (in alcohol, vial #3) from a laboratory culture of the Miyun County Biological Control Experiment Station, Beijing Municipality, July 8, 1979. Cultured on eggs of giant oak silkworm, Antheraea pernyi. Origin of original Trichogramma stock not known.[4/]

See footnotes at end of appendix.

2. "T. ostriniae" in parasitized eggs of the rice moth, Corcyra cephalonica (vial #4), from a laboratory culture of the Miyun County Biological Control Experiment Station, Beijing Municipality, July 8, 1979. Original Trichogramma stock obtained locally ex Ostrinia sp. No parasites emerged from this material.

3. "T. dendrolimi" adults (in alcohol, vial #6) from a laboratory culture of the Liuhe County Biological Control Experiment Station, Tonghua Region, Jilin Province, July 12, 1979. Cultured on eggs of Antheraea pernyi. Original Trichogramma stock obtained locally; original host not known.[4]

4. "T. confusum" adults (originally called T. "australicum") (in alcohol, vial #7) from a laboratory culture of the Liuhe County Biological Control Experiment Station, Tonghua Region, Jilin Province, July 12, 1979. Laboratory host not known. Original Trichogramma stock obtained locally; original host not known.[5]

5. "T. ostriniae" adults (in alcohol, vial #8) from a laboratory culture of the Liuhe County Biological Control Experiment Station, Tonghua Region, Jilin Province, July 12, 1979. Laboratory host not known. Original Trichogramma stock obtained from Beijing Municipality; original host probably Ostrinia sp.[6]

6. "T. dendrolimi" adults (dry, vial #9) from a laboratory culture of the Jilin Forestry Research Institute, Changchun, Jilin Province, July 14, 1979. Cultured on eggs of Antheraea pernyi. Original Trichogramma stock probably obtained locally; original host(s) not known, but are probably Dendrolimus moths.[4]

7. "T. dendrolimi" adults (in alcohol, vial #23) from a laboratory culture of the Shilong Biological Control Experiment Station near Guangzhou, Guangdong Province, July 29, 1979. Cultured on eggs of Antheraea pernyi and/or eri silkworm, Philosamia [= Samia] cynthia ricini. Original Trichogramma stock collected locally ex "white sugarcane borer," Argyroploce schistaceana and/or "yellow sugarcane borer," Chilotraea infuscatella.[5]

8. "T. confusum?" adults (in alcohol, vial #24) ex field-collected eggs of "Diatraea" (or Proceras) venosatus [= Chilo sacchariphagus stramineelus] collected in the vicinity of the Shilong Biological Control Experiment Station near Guangzhou, Guangdong Province, received from station personnel July 29, 1979.[4]

9. "A mixture of T. dendrolimi and T. evanescens" adults (in alcohol, vial #25) ex field-collected eggs of Argyroploce schistaceana collected in the vicinity of the Shilong Biological Control Experiment Station near Guangzhou, Guangdong Province, received from station personnel July 29, 1979.[4] [7]

C. Other Parasites and Predators Received from Laboratories Visited

1. "Anastatus bifasciatus" (Hym.: Eupelmidae) adults (in alcohol) from a laboratory culture of the Jilin Forestry Research Institute, Changchun, Jilin Province, July 14, 1979. Cultured on eggs of Antheraea pernyi. Original stock probably collected locally; original host not known (target host = Dendrolimus superans).8/

2. Amblyseius tsugawai and A. deleoni (Acarina: Phytoseiidae) adults (in alcohol and on microscope slides) from a laboratory culture of the Department of Biology, Fudan University, Shanghai. Original stock collected in Shanghai Municipality. Received from department personnel July 20, 1979.9/

3. Specimens of several species of parasites of Pieris [= Artogeia] rapae, and host specimens, presumably from field collections in vicinity of Hangzhou, Zhejiang Province (data in Chinese). Received from Department of Plant Protection, Zhejiang Agricultural University, Hangzhou, July 25, 1979.10/

4. "Apanteles species (possibly 2)" (Hym.: Braconidae) adults and cocoons (dry in vials) ex the tea looper, Ectropis obliqua, presumably from field collections in vicinity of Hangzhou, Zhejiang Province. Received from personnel of the Tea Research Institute, Hangzhou, July 25, 1979. 11/

5. Chilocorus kuwanae (Col.: Coccinellidae) adults presumably from field collections in the vicinity of Hangzhou, Zhejiang Province. Received from personnel of the Tea Research Institute, Hangzhou, July 25, 1979. 12/

6. Anastatus sp. (new?) (Hym.: Eupelmidae) adults (in alcohol) from a laboratory culture of the Shilong Biological Control Experiment Station, near Guangzhou, Guangdong Province, July 29, 1979. Cultured on eggs of eri silkworm, Philosamia [= Samia] cynthia ricini. Original stock presumably collected in vicinity of Guangzhou, Guangdong Province; original and target host is the litchi stink bug, Tessaratoma papillosa.8/

D. Specimens Field-Collected by U.S. Delegation

1. Aphids and ladybugs collected from corn and soybean near Liuhe, Liuhe County, Tonghua Region, Jilin Province, July 12, 1979.13/

1/ See also Appendix 2 for list of live pathogens received, and information on their identification.

2/ All specimens were determined to be _Ostrinia furnacalis_ (Guenée) by D. C. Ferguson, USDA Systematic Entomology Laboratory, Washington, D.C. Identification also confirmed by E. Monroe, Canada Agriculture, Biosystematics Research Institute, Ottawa (retired). Genitalia were removed and slide-mounted to effect identification. The identification of these specimens as _O. furnacalis_, not _O. nubilalis_ (Hubner), is at least partially confirmed by the results of pheromone attractant studies in China; see notes for July 6 and Klun et al., 1980.

3/ These vials of specimens were all examined by C. E. Goodpasture, USDA Beneficial Insect Introduction Laboratory, Beltsville, Maryland. All males from all samples were mounted on microscope slides, which were critically examined and upon which the comments in footnotes 4 through 7 are based. However, only one or two males were present in some samples. Since identifications of _Trichogramma_ species are based almost entirely on male morphological characteristics, more extensive samples are needed for a more meaningful study. Furthermore, Dr. Goodpasture could not make actual species identifications of PRC material because of the lack of access to type specimens and the absence of reliable revisionary work covering Old World _Trichogramma_ fauna. Nevertheless, the comments on the samples expressed in footnotes 4 through 7 are considered to be of some interest and value.

4/ Material in samples 1, 3, 6, 8, and 9 appeared to represent a single species, which was called _T. dendrolimi_ by PRC identifiers. Dr. Goodpasture noted that he could not distinguish between _T. dendrolimi_ and _T. confusum_ [?= _T. chilonis_] without reference to type specimens. He commented: "These two species are very similar and may be siblings. For example, [samples 1, 3, 6, and 9] are identified as _T. dendrolimi_. [Samples 4 and 8] are labeled _T. confusum_. I can find no consistent differences between these 'species'. ..... Note that the original descriptions of _T. dendrolimi_ and _T. confusum_ are very brief [and] do not mention the important characters such as genitalia and/or flagellar morphology such that neither species could be recognized on the basis of the descriptions. Nagarkatti and Nagaraja (1971) provide a redescription of _T. dendrolimi_ and _T. confusum_ (their _T. australicum_ [according to Viggiani (1976)]). In [their] redescription, genitalia and antennal characters are described. However, the PRC _dendrolimi/confusum_ specimens do not fit the redescription well. For example, the male flagellar setae are long and tapering in these species according to Nagarkatti and Nagaraja. The antennal setae are short and blunt in the PRC specimens. It seems that either the PRC specimens or the Nagarkatti material is misidentified -- perhaps both are wrong. Only a study of type specimens would [clear up this confusion]." Dr. Goodpasture also noted that it might be likely that "_T. dendrolimi_" and "_T. confusum_" might be mutual contaminants of some or all of the samples, thus compounding the confusion.

5/ See footnote 4 regarding confusion between identification of PRC "T. dendrolimi" and "T. confusum." Samples 4 and 7 apparently represented mixed cultures. According to Dr. Goodpasture, the genitalia of these specimens were dendrolimi/confusum-like but the male flagellae were highly variable. He noted that two species were perhaps present: one with dendrolimi/confusum genitalia and short, blunt flagellar hairs (= PRC "T. dendrolimi") and a second species with dendrolimi/confusum genitalia and unusually long, tapering "evanescens-like" flagellar setae. He also noted that "T. dendrolimi" and "T. confusum" were likely mutual contaminants of these samples.

6/ Specimens from this sample were apparently T. ostriniae. The sample was found to be pure and excellently preserved. Dr. Goodpasture also noted that the species could be readily separated from the North American species T. nubilale Ertle & Davis by differing genitalia, flagellar and mesoscutellar characteristics.)

7/ Though this was reported as a possibly mixed sample, no "T. evanescens" were found among the four males recovered from the sample. Several additional runted males were found in the sample but were not slide-mounted since runted specimens, because of altered morphology with reduced size, are not useful for taxonomic identification. (Dr. Goodpasture noted that runted males are commonly found in long-term laboratory cultures, and in fact normal males may be entirely absent in such cases, making identification based on morphology impossible.)

8/ Both lots of Anastatus were determined to be A. japonicus Ashmead (Hym.: Eupelmidae) by E. E. Grissell, USDA Systematic Entomology Laboratory, Washington, D.C. He noted: "I believe these are host-induced size variants of the same species. The only way to know for certain would be to have reciprocal cross host tests which I suggest be attempted."

9/ Specimens were identified as Typhlodromips tsugawai Ehara and Amblyseius herbicolus (Chant) (synonym = A. deleoni M. & D.) (Acarina: Phytoseiidae) by H. A. Denmark, Florida Department of Agriculture, Gainesville, Florida.

10/ Specimens were identified as follows:

Exorista sorbillans (Wiedemann) and Phryxe vulgaris (Fallén) (Dipt.: Tachinidae) by C. W. Sabrosky, USDA Systematic Entomology Laboratory, Washington, D.C.

Coccygomimus disparis (Viereck) (Hym.: Ichneumonidae) by R. W. Carlson, USDA Systematic Entomology Laboratory.

Brachymeria lasus (Walker) and B. femorata (Panzer) (Hym.: Chalcididae) and Pteromalus puparum (L.) (Hym.: Pteromalidae) by E. E. Grissell, USDA Systematic Entomology Laboratory.

Artogeia rapae crucivora (Boisduval) (Lep.: Pieridae) by W. D. Field, Department of Entomology, U.S. National Museum of National History, Washington, D. C.

11/ Specimens were identified as follows by P. M. Marsh, USDA Systematic Entomology Laboratory:
 Apanteles sp. (Hym.: Braconidae) -- 15 specimens ("Runs to *A. arcuatus* Telenga in his key to *Apanteles* of the USSR. ... We have no specimens [of *arcuatus*] to compare").
 Apanteles sp. -- 15 specimens (all male) ("Different than [above species]").

12/ Identity confirmed by Dr. Hagen as *C. kuwanae* Silvestri.

13/ Aphid specimens collected by Mr. Coulson were identified as follows by M. B. Stoetzel, USDA Systematic Entomology Laboratory:
 Rhopalosiphum padi (L.) and *Aphis* sp., prob. *glycines* (Matsumura) (Hom.: Aphididae).
Aphid specimens collected by Dr. Hagen were identified as follows by D. Hille Ris Lambers, Bennekom, Netherlands:
 Aphis glycines (Matsumura) and *Aulacorthum solani* (Kaltenbach); a parasite emerged from mummified specimens of *A. solani*, and was identified as an *Aphidius* sp. by Dr. Hagen.
Coccinellid specimens collected and identified by Dr. Hagen were as follows:
 Harmonia axyridis (Pallas), *Propylaea japonica* (Thunberg) and *Thea vigintiduopunctata* (L.).

PRELIMINARY LIST OF BIOLOGICAL MATERIALS AVAILABLE IN CHINESE INSTITUTIONS (1979)

Natural Enemies	Insects to be Controlled
Macrocentrus "simearis (Nees)" [?= M. linearis (Nees)]	Ostrinia "nubilalis" 1/
Apanteles sp.	Plutella xylostella
Aphidius "avenae Fitch" [?= A. avenae Haliday]	Macrosiphum avenae, and other aphids
A. gifuensis Ashmead	Myzus persicae, and other aphids
Ephedrus persicae Froggatt	Hyalopterus arundinis [= pruni], and others
E. plagiator (Nees)	Macrosiphum avenae, Hyalopterus arundinis
Praon volucre (Haliday)	Macrosiphum avenae
Binodoxys indicus (Subba Rao & Sharma)	Aphis gossypii
Brachymeria lasus (Walker)	Lepidopterous pupae
Anastatus disparis (Ruschka)	Porthetria [= Lymantria] dispar, Dendrolimus spp.
Trichogramma confusum Viggiani	Cnaphalocrocis medinalis
T. dendrolimi Matsumura	Dendrolimus spp. and other lepidopterous eggs
T. japonicum Ashmead	Rice-field Lepidoptera
T. ostriniae Pang & Chen	Ostrinia "nubilalis" 1/
Telenomus dendrolimusi Chu	Dendrolimus spp.
Chrysopa formosa Brauer	Lepidopterous larvae, aphids
C. phyllochroma Wesmael	" " " "
C. septempunctata Wesmael	" " " "
C. sinica Tjeder	" " " "
Stethorus punctillum Weise	Tetranychus urticae, and other mites
Adonia variegata (Goeze)	Aphis gossypii, Macrosiphum avenae
Coccinella septempunctata L.	Aphis gossypii
Propylaea japonica (Thunberg)	Aphididae
Rodolia rufopilosa Mulsant	Icerya purchasi
Cyrtorhinus lividipennis Reuter	Rice field planthoppers
Beauveria bassiana (Bals.) Vuill.	Lepidopterous larvae, etc.
Bacillus thuringiensis Berliner	" "
Virus (NPV)	Dendrolimus spp.
Virus (NPV)	Euproctis similis

1/ See notes on identity of Chinese Ostrinia in Appendix 5.

PEOPLE'S REPUBLIC OF CHINA

PLANT IMPORTATION QUARANTINE LIST

(Issued by the Ministry of Agriculture, September, 1966)

[Rearranged taxonomically and alphabetically from original list, and English common names added]

Plant Pathogens (Diseases)

Ceratostomella ulmi Buisman (Dutch elm disease)
Colletotrichum hibisci Pollaci (Dieback, anthracnose on Hibiscus)
Cronartium ribicola Fischer (White pine blister rust)
Deuterophoma tracheiphila Petri (Phoma on lemon)
Diplodia corchori Syd.
Fusarium vasinfectum Atk. (Cotton wilt)
Peronospora tabacina Adam (Blue mold of tobacco)
Phymatotrichum omnivora (Shear) Duggar (Cotton root rot)
Pseudomonas savastanoi (E. F. Smith) Stevens (Olive knot)
Pseudomonas syringae f. populea Sabet et Dowson (Bacterial leaf spot)
Synchytrium endobioticum (Schilb) Per. (Potato wart disease)
Tilletia contraversa Kuhn (Dwarf bunt of wheat)
Uromyces betae (Persoon) Leveille (Beet rust)
? (Yellow dwarf [a barley-wheat or rice virus disease])

Insects

Anthonomus grandis Boheman (Boll weevil)
Bruchophagus spp. (Seed chalcids)
Callosobruchus maculatus (F.) (Cowpea weevil)
Ceratitis capitata (Wiedemann) (Mediterranean fruit fly)
Contarinia sorghicola (Coq.) (Sorghum midge)
Dacus dorsalis Hendel (Oriental fruit fly)
Gnorimoschema [= Phthorimaea] operculella (Zeller) (Potato tuberworm)
Leptinotarsa decemlineata (Say) (Colorado potato beetle)
Mayetiola destructor (Say) (Hessian fly)
Necrobia rufipes (DeGeer) (Redlegged ham beetle)
Pectinophora gossypiella (Saunders) (Pink bollworm)
Phthorimaea [= Scrobipalpa] ocellatella (Boyd)
Phylloxera vastatrix Planchon [= Daktulosphaira vitifoliae (Fitch)] (Grape phylloxera)
Rhagoletis pomonella (Walsh) (Apple maggot)
Scolytus scolytus (F.) and S. multistriatus (Marsham) (Elm bark beetles)
Sitophilus granarius (L.) (Granary weevil)
Trogoderma granarium Everts (Khapra beetle)

Other Organisms

Anguillulina angusta Goodey [= Ditylenchus angustus (Butler) Filipjevi] (Rice stem nematode)
Heterodera rostochiensis Woll. (Golden nematode of potato)
Lolium temulentum L. (Darnel, a weed)

LIST OF INSECT, MITE, AND TICK TAXONOMISTS, AND THEIR SPECIALITIES, OF RESEARCH INSTITUTES VISITED IN THE PEOPLE'S REPUBIC OF CHINA BY THE U.S. BIOLOGICAL CONTROL DELEGATION[1/]

Beijing Institute of Zoology, Chinese Academy of Sciences, Department of Taxonomy and Faunology:[2/]

Prof. Dr. Zai Banghua (Tsai Pang-hua), Dept. Chief ... Isoptera, Scolytoidea.
Prof. Dr. Zhao Yangchang (Chao Yang-chang), Assoc. Dept. Chief ... Curculionoidea, Dermestidae.
Prof. Dr. Chen Sexiang (Chen Secien, Chen S. H.) ... Chrysomelidae.
Prof. Dr. Zhu Hongfu (Chu H. F.) ... Geometridae, Sphingidae, Saturniidae, Bombycidae, Drepanidae, Hepialidae, Brahmaeidae, Uraniidae, Pterothysanidae, Callidulidae, Endromidae, Epicopeiidae.
Prof. [Li Zhuanlong (?)] (Lee Chuan-lung) ... Rhopalocera.
Tan Juanjie (T'an Chüan-chieh (Assoc. Res. Scientist) ... Meloidae, Cicindelidae, Eumolpidae.
Yu Peiyu (Assoc. Res. Scientist) ... Carabidae, Crioceridae.
Pu Fuji (Pu F. J.) (Assist. Res. Scientist) ... Cerambycidae.
Chang Youwei (Assist. Res. Scientist) ... Scarabaeoidea.
Li Hongxing (Lee Hung-hsing) (Assist. Res. Scientist) ... Bruchidae.
Chen Yuanqing (Res. Assist.) ... Curculionoidea.
Wang Pingyuan (Assoc. Res. Scientist) ... Pyralidae, Zygaenidae.
[Liu Youjiao (?)] (Liu Yu-chiao) (Assoc. Res. Scientist) ... Tortricidae, Cochylidae, Ethmiidae.
Chen Yixin (Assist. Res. Scientist) ... Noctuidae, Agaristidae, Cossidae.
Fang Chenglai (Assist. Res. Scientist) ... Arctiidae, Amatidae, Hypsidae.
Cai Rongquan (Assist. Res. Scientist) ... Notodontidae, Limacodidae.
[Zhao Zhongling (?)] (Chao Chung-ling) (Assist. Res. Scientist) ... Lymantriidae, Psychidae, Thyatiridae.
Liao Dingxi (Liao Ting-shi) (Assoc. Res. Scientist) ... Chalcidoidea.
Wu Yanru (Wu Yen-ju) (Assoc. Res. Scientist) ... Apoidea, Proctotrupoidea.
Wang Sufang (Assist. Res. Scientist) ... *Bombus*, Ichneumonidae.
Li (Lee) Tiesheng (Assist. Res. Scientist) ... Ceratopogonidae, Vespoidea.
Wang Jinyin (Wang King-yen) (Res. Assist.) ... Braconidae.
Huang Fusheng (Assoc. Res. Scientist) ... Scolytidae, Protura, Zoraptera.
Yin Huaifeng (Assoc. Res. Scientist) ... Scolytidae, Platypodidae.
[Hou Taojian (?)] (Hou Tau-chien) (Assist. Res. Scientist) ... Lasiocampidae, Thaumetopoeidae, Buprestidae.
Zhao Jianming (Chao Chien-ming) (Assoc. Res. Scientist) ... Tachinidae, Sarcophagidae.
Shi Yongshan (Assist. Res. Scientist) ... Tachinidae.
Sun Caihong (Sun T. H.) (Assist. Res. Scientist) ... Syrphidae, Anthomyiidae, Calliphoridae, Muscidae.
Ma Sufang (Assist. Res. Scientist) ... Culicidae.

See footnotes at end of appendix.

Wang Zunming (Res. Assist.) ... Tabanidae.
Zhang Guangxue (Chang Kuang-hsüeh) (Assoc. Res. Scientist) ... Aphidoidea, Thysanoptera.
Teng Kuofan (Assoc. Res. Scientist) ... Ixodoidea, Gamasoidea, Anoplura.
[Wang Cejing (?)] (Wang Tze-ching) (Assist. Res. Scientist) ... Coccoidea.
Wang Huifu (Assist. Res. Scientist) ... Tetranychidae.

Fudan University, Shanghai, Biology Department:

Prof. Xin Jieliu (Shin Kai-lou) ... Acarina.

Shanghai Institute of Entomology, Chinese Academy of Sciences, Laboratory of Taxonomy and Ecology:

Dr. Xia Kailing (Hsia K'ai-ling), Lab. Chief ... Acridoidea, Isoptera.
Mme Jin Qinying, Curator.
Fan Zide (Fan Tzu-te) ... Anthomyiidae, Muscidae, Calliphoridae, Sarcophagidae, "etc." [not including Tachinidae].
Wang Xiaozu (Wang Hsiao-tsu) ... Acaridae, Cheyletidae.
Yang Pinglan (Young Bain-ley) ... Aleyrodidae, Coccoidea.
Yin Wenying ... Protura.

Zhejiang Agricultural University, Hangzhou, Zhejiang Province, Department of Plant Protection:

He Junhua (He Chün-hua)[3/] ... Ichneumonoidea.
Prof. Li Xueliu (Lee H. T.) ... Chalcidoidea.
Zhu Ruzuo ... "Beneficial insects."

Zhongshan (Sun Yat Sen) University, Guangzhou, Department of Biology, Entomology Research Institute:

Pu Zhelong (Pu Chih-lung), Dept. Chief ... Hydrophilidae and other aquatic Coleoptera.
[Hua Lizhong (?)] (Hua Lichung) ... Cerambycidae.
Chen Chunyao ... Scutelleridae, Pentatomidae.

Guangdong Institute of Entomology, Chinese Academy of Sciences, Guangzhou, Insect Taxonomy Division:

Names of taxonomists not obtained (see journal notes for July 27).

South China Agricultural College, Guangzhou, Plant Protection Department:

Pang Xiongfei (Pang Hsiung-fei), Dept. Deputy Director ... Coccinellidae, Trichogrammatidae.
Chen Shoujian ... Carabidae.

Fujian Agricultural College, Shaxian, Fujian Province:[4/]

Zhao Xiufu (Chao Hsiu-fu)[5/] ... Ichneumonoidea.
Chen Jiahua ... Aphidiidae.

1/ See also Appendix 1 for additional PRC taxonomists.

2/ Chen Tailu, trichogrammatid and scelionid specialist, was omitted, apparently accidentally, from the list of institute taxonomists given to the delegation at the institute on July 10, 1979.

3/ Not met on U.S. delegation's visit. Later was a member of the Chinese delegation that visited the United States in August-September 1979.

4/ Location not visited by U.S. delegation.

5/ Met in Beijing. Later was a member of the Chinese delegation who visited the United States in August-September 1979.

FOREST INSECT PESTS OF JILIN PROVINCE

HEMIPTERA-HOMOPTERA

Lepidosaphes ulmi (L.)

COLEOPTERA

Curculio arakawai Matsumura & Koko
Curculio dieckmanni Faust.
Cyllorhynchites ursulus (Roelofs)
Chrysomela populi L.
Chrysomela salicivorax (Fair.)
Galerucella (Pyrrhalta) aenescens Fairm.
Galerucella [= Pyrrhalta]
  maculicollis Motsch.
Parnops glasunowi Jacobs.
Cryptorrhynchus lapathi (L.)
Pissodes nitidus Roelofs
Poecilonota variolosa (Paykull)
Saperda populnea (L.)
Blastophagus [= Tomicus] piniperda (L.)

DIPTERA

Hylemyia [= Lasiomma] laricicola Karl.

LEPIDOPTERA

Ambrostoma quadriimpressum (Motsch.)
Dendrolimus superans Butler
Malacosoma neustria testacea Motsch.
Gastropacha populifolia (Esper)
Gastropacha quercifolia (L.)
Bhima idiota Graeser
Amorpha amurensis Staudinger
  [= Boisduval]
Callambulyx tartarinovi Bremer & Grey
Smerinthus caecus (Ménétriés)
Smerinthus planus (Walker)
Clostera anachoreta (F.)
Pheosia tremula (Clerck)
Cerura erminea menciana (Moore)
Cerura vinula felina (Butler)
Harpyia lanigera (Butler)
Ivela ochropoda (Eversmann)
Leucoma candida (Staudinger)
Leucoma salicis (L.)
Ocneria [= Lymantria] dispar (L.)
Orgyia antiqua (L.)
Papilio xuthus L.
Aporia crataegi (L.)
Coleophora laricella (Hübner)
Cnidocampa (Monema) flavescens Walker
Laspeyresia grunertiana Ratzeburg
  [= Cydia pactolana (Zeller)]
Rhyacionia duplana Hübner
Dioryctria mendacella Staudinger
Dioryctria splendidella
  Herrich-Schäffer
Holcocerus vicarius Walker
Cossus cossus (L.)
Phassus excrescens Butler

LIST OF INSECTS OBSERVED AT LIGHT TRAPS IN WU COUNTY, SUZHOU REGION, JIANGSU PROVINCE

ORTHOPTERA

Gryllotalpa unispina
G. africana

HOMOPTERA

Nephotettix bipunctatus [= N. virescens]
Empoasca subrufa
Deltocephalus dorsalis
Macrosteles fascifrons
M. fuscinervis
Amblycephalus [= Cicadella] viridis
Eutettix [= Litura] disciguttus[1/]
Nilaparvata bakeri
N. lugens
N. muiri
Delphacodes [= Harmalia] sameshimai
D. [= Laodelphax] striatella
Toya propinqua
Saccharosydne procerus
Nisia atrovenosa
Sogatella furcifera
S. panicicola
S. sirokata
Unkanodes sapporona
Terthron albovittatum

COLEOPTERA

Anomala corpulenta

LEPIDOPTERA

Spilosoma subcarnea
Thosea postornata
T. sinensis
Parasa consocia
P. lepida
Cnidocampa flavescens
Actias selene
Theretra oldenlandiae
Clanis bilineata
Marumba gaschkewitschii
Schoenobius [= Tryporyza] incertulas
Chilo suppressalis
Dichocrocis punctiferalis
Pyrausta [= Ostrinia] nubilalis[2/]
Oebia [= Hellula] undalis
Glyphodes [= Diaphania] indica
Scirpophaga nivella
Etiella zinckenella
Nymphula vittalis
Ancylolomia chrysographella
Cnaphalocrocis medinalis
Agrotis tokionis
A. ypsilon [= ipsilon]
Prodenia [= Spodoptera] litura
Phytometra sp.
Sesamia inferens
Naranga aenescens

1/ According to Dr. J. P. Kramer, USDA's Systematic Entomology Laboratory, this species is not known to occur in China; the species referred to here is probably Hishimonus sellatus (Uhler).

2/ See Appendix 5 for notes on identity of Ostrinia spp. in China.

RICE PESTS OF CHANGSHU COUNTY, SUZHOU REGION, JIANGSU PROVINCE

PATHOGENS

Piricularia oryzae Cav.
Pellicularia sasakii (Shirai) Wei
Gibberella fujkuroi (Saw.) "Wellenweber" [= Ito ap. Ito E Kimura]
Xanthomonas oryzae Ugeda & Ishiyama
Cercospora oryzae Miyake
Cochliobolus miyabeanus (Ito & Kurib.) Drechsler
Oryzae virus 1 Smith
Oryzae virus 2 Smith

INSECTS

Thrips oryzae Williams
Sesamia inferens Walker
Chilo suppressalis Walker
Tryporyza incertulas (Walker)
Delphacodes [= *Laodelphax*] *striatella* (Fallén)
Nilaparvata lugens (Stal)
Sogatella furcifera (Horvath)
Nephotettix cincticeps (Uhler)
Parnara [= ? *Pamphila*] *guttata* Bremer & Gray
Cnaphalocrocis medinalis (Guenée)

MAJOR CROP PESTS OF TAICANG COUNTY, SUZHOU REGION, JIANGSU PROVINCE

RICE

Thrips oryzae Williams
Nephotettix bipunctatus cincticeps (Uhler)[= *N. cincticeps* (Uhler)]
Laodelphax striatella (Fallén)
Schoenobius [= *Tryporyza*] *incertulas* (Walker)
Chilo suppressalis Walker
Sesamia inferens (Walker)
Cnaphalocrocis medinalis (Guenée)
Sogata [= *Sogatella*] *furcifera* (Horvath)
Nilaparvata lugens Stal
Oryzae virus 1 Smith
Oryzae virus 2 Smith
Pellicularia sasakii (Shirai) Wei
Piricularia oryzae Miyake

WHEAT

Leucania [= *Pseudaletia*] *separata* (Walker)
Rhopalosiphum prunifoliae (Fitch) [= *fitchii* (Sanderson) = *padi* (L.)]
Erysiphe graminis DC f. sp. *tritici*
Gibberella zeae (Schw.) Petch

COTTON

Agrotis ypsilon (Rottemberg) (= *ipsilon* Hufnagel))
Aphis gossypii Glover
Tetranychus bimaculatus Harvey
Lygus lucorum Meyer-Dur
Pectinophora gossypiella (Saunders)
Heliothis armigera Hubner
Ascochyta gossypii Syd.
Rhizoctonia solani Kuhn

RAPE

Rhopalosiphum pseudobrassicae (Davis) [= *Hyadaphis erysimi* (Kaltenbach)]
Myzus persicae (Sulzer)
Albuge candida (Pers. ex Chev.) (Kuntze)
Brassica virus 2
Peronospora parasitica Pers. ex Fr.
Sclerotinia sclerotiorum (Lib.) de Bary

CITRUS PESTS OF SUZHOU REGION, JIANGSU PROVINCE, AND INSECTICIDES USED IN THE AREA

CITRUS PESTS [1]

Podagricomela nigricollis Chen (citrus leafminer)
Anoplophora chinensis (Forster) (citrus trunk borer)
Nadezhdiella cantori (Hope) (citrus trunk cerambycid)
Phyllocnistis citrella Staint. (citrus leafminer)
Ceroplastes rubens Mask. (red wax scale)
Icerya purchasi Mask. (cottonycushion scale)
Unaspis yanonensis (Kuw.) (yanon scale)
Phyllocoptes [= *Phyllocoptruta*] *oleivora* (Ashm.) (citrus rust mite)
Panonychus citri (McGregor) (citrus red mite)
Selepa celtis Moore
Microleon longipalpis Butler (long-palpi cochlid)

INSECTICIDES USED ON CITRUS

$C_4H_8O_4Cl_3P$ -- Dipterex, Dylox, Trichlorphon, Tugon, Neguvon
$C_4H_7O_4Cl_2P$ -- DDVP, Dichlorvos, Herkol, Nogos, Nuvan, Vapona
$C_{10}H_{19}O_8PS_2$ -- Malathion, Emmatos, Karbofos, T M4049, Melphos
$C_{11}H_{16}O_2ClPS_3$ -- Trithion, Carbophenothion, R-1303, Garrathion
$C_{11}H_{12}O_4NPS_2$ -- Imidan, PMP, Prolate, Stauffer R-1504, Phytalophos, Percolate

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1/ Common names are from Xin & Xia, 1978.

IMPORTANT NATURAL ENEMIES OF COTTON PESTS IN THE SHANGHAI AREA

1. *Aphis gossypii* (Glover)

   COCCINELLIDAE: *Scymnus* (*Neopullus*) *hoffmanni* Weise, *Propylaea japonica* (Thunberg)
   CHRYSOPIDAE: *Chrysopa sinica* Tjeder, *Chrysopa septempunctata* Wesmael
   SPIDERS: *Micryphantes* [= *Tmeticus*] *graminicola* (Sundevall) (= *Erigonidium graminicola*), *Misumena tricuspidata* (F.) (= *Misumenops tricuspidatus*)
   ANTHOCORIDAE: *Orius minutus* L.
   SYRPHIDAE: *Syrphus* [= *Metasyrphus*] *corollae* (F.), *Epistrophe* [= *Episyrphus*] *balteata* DeGeer
   APHIDIIDAE: 3 spp. [not listed]

2. *Platyedra* [= *Pectinophora*] *gossypiella* (Saunders)

   PTEROMALIDAE: *Dibrachys cavus* (Walker)
   BRACONIDAE: *Bracon nigrorufum* (Cushman), *Bracon isomera* (Cushman)
   TRICHOGRAMMATIDAE: *Trichogramma japonicum* Ashmead, *Trichogramma chilonis* Ishii
   EULOPHIDAE: *Tetrastichus schoenobii* Ferriere

3. *Tetranychus urticae* Koch

   COCCINELLIDAE: *Stethorus punctillum* Weise

ANTIBIOTICS USED FOR PLANT DISEASE CONTROL IN CHINA, 1979

Antibiotic	Target Disease	Organism Producer	Discovered or Developed by	Usage
Blastocidin	Rice blast	*Streptomyces* sp.	Japanese	2-3 g/mu. 2,000 kg (pure) produced in China each year. (Phytotoxic--also to humans.)
"Jingguong" [?]	Rice sheath blight	*S. hygroscopicus* var. *jinggagensis*	Shanghai Inst. Agric. Chemicals	30-40,000,000 mu rice/year.
"Quing fengmycin"	Fish gill rot, Rice blast, Powdery mildew	*Streptomyces* sp. (plate contaminant)	Shanghai Inst. Plant Physiology	Not used; too expensive and harmful to humans.
Validamycin	Rice sheath blight	?	Japanese	Not used; too expensive and harmful to humans.
"Multiple-antibiotic" Polyoxin	*Alternaria* on tobacco and peach	*Streptomyces* sp.	Japanese	Small usage -- high-value crops only; too expensive.
"Internal antibiotic"	Apple canker and smut of millet	*Streptomyces* sp. from soil	Atomic Energy Res. Inst. Chinese Acad. Agric. Sci., Beijing	Factory in Heilongjiang Province.
5406-Bacterial Fertilizer	Improves vigor and stands of cotton and wheat--early stage of growth	*Streptomyces* sp.	Lab. of Agricultural Antibiotics, Chinese Acad. Agric. Sci., Beijing	Commune production only.

DISTINCTION BETWEEN "APHIDICIDE"-PRODUCING FUNGUS AND

Streptomyces griseolus Waksman

Culture and physiological characteristics	*S. griseolus* var. *hangzhouensis* n. var.Yan et Fang	*S. griseolus* Waksman
Glucose		
Asparagus		
Hyphae	brown to dark brass color	cream color turned dark
Soluble pigment	yellow (like bean milk)	none
Potato chunks		
Hyphae	green, turned olive grey	cream color turned black
Soluble pigment	slightly brown	brown to black
Milk		
solidify	does not solidify	slowly solidify
peptonization	peptonize	peptonize well
Nitrate	weakly reduce	reduce
Gelatin	does not liquify	liquify
Starch	strongly hydrolyze	slightly hydrolyze
Cellulose	does not utilize	slightly utilize

MAJOR INSECTS AND DISEASES AND THEIR NATURAL ENEMIES OF "RED-IN-THE-EAST" COMMUNE, XIAOSHAN COUNTY, ZHEJIANG PROVINCE

PEST ORGANISMS

Pellicularia sasakii (Shirai) Wei (sheath blight)
Xanthomonas oryzae Ugeda & Ishiyama (bacterial leaf blight of rice)
Cnaphalocrocis medinalis (Guenee) (rice leafroller)
Nilaparvata lugens (Stal) (brown planthopper)
Nephotettix cincticeps (Uhler) (rice leafhopper)
Chilo suppressalis Walker (rice stemborer)
Chloeothrips oryzae (Williams) [= Baliothrips biformis (Bagnall)] (rice thrips)

NATURAL ENEMIES

Paracentrobia andoi (Ishii) (trichogrammatid)
Trichogramma confusum Viggiani (trichogrammatid)
Apanteles cypris Nixon (ex pyralids)
Erigonidium [= Tmeticus] graminicolum (Sundevall) (spider)
Lycosa [= Pardosa] pseudoannulata (Strand) (spider)
Pirata piraticus (Olivier) (spider)
Cyrtorhinus lividipennis Reuter (suckfly) (Miridae)
Paederus fuscipes Curtis (rove beetle)
Rana limnocharis (Grav.) (frog)

ABSTRACTS OF RESEARCH AREAS OF THE GUANGDONG INSTITUTE OF ENTOMOLOGY, 1979

Studies on the Sex Pheromone of the Rice Gall Midge

Pachydiplosis (*Orseolia*) *oryzae*

(Insect Sex Pheromone Group, Guangdong Entomological Institute)

The rice gall midge (R.G.M.) is a serious pest of rice in Southeastern Asia and South China. In recent years this pest gradually caused serious damage in our Province. The longevity of adults is very short, only 1 or 2 days. The sex ratio is over 70 percent females. For the overlap generations, the prediction and the control of the pest are still difficult.

The apparent phenomenon of sex attraction of R.G.M. was observed with water basin traps. The newly emerged virgin females, even the older pupae begin to release sex pheromone, but 2-day-old females are more attractive to males than 1-day-old females.

Active extracts were obtained by the "washing" method or the solvent extraction of whole females. The effect of the "washing" method is better than extraction of whole females in potency and pureness of the extract. All extracts from the different segments of R.G.M. females have attractive activity. The extracts prepared with methylene chloride and ether are more potent than ethylene chloride, acetone, dimethyl benzene or 95 percent ethanol. The time of adsorption by the "washing" method is at least one night. But the extracts of adsorption or solvent extraction during the daytime were not attractive at all.

The extracts were concentrated with K-D concentrator. The isolation of sex attractant of R.G.M. involved a combination of chromatographic techniques (column, thin-layer and gas). TLC showed that the polarity of the active component is stronger. GC on a column of 5 percent PEG-20M showed the presence of two active components.

The insect predictive field trials were conducted in the summer from 1976 to 1977 at the Agricultural Institute of Hua County using two water basin traps, each trap baited with two virgin females. The trials showed that prediction using sex attraction can correctly reflect the outbreak period, the count of relative quantity of R.G.M. adults is easy and the procedure is convenient. But the effects of the sex attraction in field control were not apparent.

Studies on the Integrated Control of the Citrus Red Mite with the Predaceous Mite as a Principal Controlling Agent

Division of Biological Control, Guangdong Entomological Institute
Experimental Station, Satian Orchard, Guangzhou

In the citrus orchards in the Guangzhou suburbs, the predaceous mites, chrysopids, mite-eating ladybirds, certain species of thrips, and spiders have been found to be the natural enemies of the citrus red mite, *Panonychus citri* (McG.), among which *Amblyseius newsami* (Evans) is a dominant species and always outnumbers the others from 1.5 to 1 up to 4 to 1.

Promising results have been obtained from the experiments of integrated control in 1975 and 1976 by the utilization of *A. newsami* as a principal controlling agent supplemented with the application of a small quantity of selective chemical insecticides and the implementation of agricultural techniques. By these measures, the population of the citrus red mite has been checked below the economic threshold and accordingly the quantity of insecticides applied has decreased. The results of 2 years' experiments indicated that this is a proper device for citrus red mite control.

The shorter life cycle, the preference for preying upon the target mite, the polyphagous habit and the coincidence in distribution with hosts are important features for *A. newsami* as an effective controlling agent. Moreover, the resistance of *A. newsami* to the pesticides such as Kelthane, lime-sulfur, Sevin, colloidal sulfur, BHE, DDT, Bassa, and Topsin is quite advantageous to the integrated control of citrus insect pests.

In the citrus orchards in Guangzhou suburbs, the wild plant *Ageratum conyzoides* Linn. occurs, the pollen of which, as well as the psocids on this plant, are normally consumed by the predaceous mite. As this plant grows and blossoms in the orchards all the year round, it seems to be important in maintaining the population of the predaceous mite.

Studies on Natural Enemies of the Rice Gall Midge

(Abstract)

The rice gall midge (Pachydiplosis oryzae) is one of the important insect pests of rice. It is distributed in southern China, and southeast and west Asian countries. The present paper reports studies on species and bionomics of parasites of the rice gall midge, and the role of parasites in integrated control.

In Guangdong Province, five primary parasites of rice gall midge were found as listed below:

(1) Platygaster sp. (polyembryonic)
(2) Platygaster sp.
(3) Neanastatus orientalis Girault
(4) Neanastatus cinctiventris Girault
(5) Obtusiclara oryzae Subba Rao

Platygaster spp. laid their eggs into the eggs of their host and the parasitic adults emerged from the pupae of their host. Neanastatus spp. and Obtusiclara were ectoparasites of their host.

The life cycle of Platygaster sp.(1) from egg to adults is 25 to 26 days under 27° to 30° C, RH 80 to 90 percent. The number of generations was seven to eight. A peak of emergence was seen between 8 to 10 P.M. The adult longevity was 3 days for males and 4 to 5 days for females. Sex ratio (female to male) was 7:1 to 9:1. The reproductive rate was observed from first generation to sixth. Results were as follows: 1st-36.30, 2nd-16.00, 3rd-27.90, 4th-37.20, 5th-43.00, 6th-16.10.

During January and June, the natural parasitism was from 10 to 40 percent. During July and October, it was increased to more than 80 or 90 percent in 1977 and 1978.

As an important biological environmental factor, natural enemies should not be neglected. They played an important role in integrated control. It was revealed that if parasitism reached more than 50 percent before a peak of the insect damage, the population of the rice gall midge was well controlled by the parasites. For example, in Lianjiang County, in 1977, the parasitism was 42.9 percent at the beginning of July; the percentage of damaged tillers was 8 percent. Afterwards, in August, the percentage of damaged tillers was as high as 11.5 percent, but the parasitism was increased to 98.6 percent. Therefore, in September, there was a marked drop in the percentage of damaged tillers; it was 1.14 percent.

Results obtained from Gaoyao County in 1977 were similar as the case of Lianjiang. Seasonal fluctuation of the population density of the parasites and the percentage of damaged tillers were as follows:

Generation	Parasitism	Percent damaged tillers
2nd	50.7 percent	28.8 Opercent
3rd	66.0 percent	40.30 percent
4th	85.7 percent	2.08 percent
5th	92.3 percent	0.28 percent
6th	53.5 percent	0.76 percent

In 1978, investigations of the relation between the parasites and the rice gall midge were carried out further in Gaoyao. The results indicated that the quantitative ratio between P. oryzae and Platygaster sp.(1) affected the parasitism of Platygaster. Results were as follows:

P. oryzae to Platygaster sp.(1)	Parasitism
4: 1	13.6 percent
2: 1	30-65 percent
1: 1	84 percent

It was shown that the control effect of parasites was increased obviously along with the increasing number of the parasites.

A List of Natural Enemies of Rice Pests in Guangdong Province

1. Natural Enemies of Lepidopterans

Trichogrammatidae

Trichogramma japonicum Ashmead
Trichogramma australicum Girault
[?= *T. confusum*]
Trichogramma dendrolimi Matsumura

Tetrastichidae

Tetrastichus schoenobii Ferriere

Elasmidae

Elasmus albopictus Crawford
Elasmus corbetti Ferriere

Chalcididae

Brachymeria obscurata (Walker)
[= *B. lasus* (Walker)]
Brachymeria excarinata Gahan
(Viereck)

Scelionidae

Telenomus dignus (Gahan)
Telenomus rowani (Gahan)

Braconidae

Apanteles ruficrus (Haliday)
Apanteles cypris Nixon
Apanteles baoris Wilkinson
Apanteles schoenobii Wilkinson
Tropobracon schoenobii (Viereck)
Rogas narangae Rohwer
Meteorus narangae Sonan
Cardiochiles sp.

Ichneumonidae

Temelucha philippinensis Ashmead
Temelucha biguttula (Munakata)
[= (Matsumura)]
Temelucha stangli (Ashmead)
Diadegma akoensis (Shiraki)
Charops bicolor (Szépligeti)
Eriborus sinicus (Holmgren)
Amauromorpha accepta schoenobii
(Viereck)
Goryphus basilaris Holmgren
Isotima javensis (Rohwer)
Xanthopimpla punctata (Fabricius)
Xanthopimpla stemmator (Thunberg)
Xanthopimpla pedator (Fabricius)
[?= *X. punctator* (L.) or *X. pedatoris* Strand]
Xanthopimpla flavolineata Cameron
Itoplectis naranyae (Ashmead)
Ishnojoppa luteator (Fabricius)

2. Natural Enemies of Planthoppers and Leafhoppers in Rice

Trichogrammatidae

Oligosita nephotetticum Mani
Oligosita shibuyae Ishii
Oligosita sp.
Paracentrobia andoi (Ishii)
(= *Japania andoi* Ishii)

Pteromalidae

Panstenon sp.

Dryinidae

Haplogonatopus japonicus
Esaki & Hashimoto

Mymaridae

Gonatocerus longicrus Kieffer
Anagrus spp.

Elenchidae

Elenchus sp.

Miridae

Cyrtorhinus lividipennis Reuter

3. Natural Enemies of Rice Gall Midge

Platygasteridae

Platygaster sp.

Girault

Platygaster sp.

Eupelmidae

Neanastatus cinctiventris

Pteromalidae

4. Predaceous Insects

Staphylinidae

Paederus fuscipes Curtis
Paederus tamulus Erichson

Carabidae

Ophionea [=*Casnoidea*] *indica* (Thunberg)
Colliuris chaudoiri Boheman
Eucolliuris [=*Colliuris*] *litura* Schmidt-Goebel

Coccinellidae

Verania discolor (Fabricius)
Synharmonia octomaculata (F.)
Coccinella repanda Thunberg

Rearing of *Trichogramma dendrolimi* in Artificial Diets.

Lu Wen-whui
Shei Tsung-nung
Shao Kwo-fang
Ouyang Din-whui
Li Li-Ying
(Guangdong Entomological Institute)

Trichogrammatid wasps, especially the wasps of *Trichogramma dendrolimi*, are widely used in China to control agricultural, horticultural, and forest pests. Insect eggs used as hosts for mass rearing this parasite are the eggs of *Philosamia* [=*Samia*] *cynthia ricini*, *Antheraea pernyi* and *Corcyra cephalonica*. However, the full potential of rearing and releasing *Trichogramma* has always been limited by the number of host eggs that can be reliably produced anywhere and at any moment. Development of an artificial host and diet would greatly increase rearing reliability and expand the area of biological control by this parasite. We have studied the problem of rearing *Trichogramma dendrolimi in vitro* since 1975. In our tests, the *Trichogramma* oviposited viable eggs in artificial wax-vaseline capsules with several different kinds of semisynthetic culture media. We have selected more than 10 kinds of culture media. The eggs of *Trichogramma* were dissected from the wax-vaseline artificial eggs with 7 to 8 µl culture medium in glass semi-spherical discs. *Trichogramma dendrolimi* could be reared *in vitro* from eggs to adults. The life cycle of *Trichogramma in vitro* was the same as that in the eggs of oak silkworm or eri silkworm. The percentage of females of the first generation adults reared *in vitro* was 71 to 100 percent, and the females could oviposit viable eggs. Approximately 25 to 79 percent of the adults reared *in vitro* in different media fully expanded their wings. The excellent culture medium in our studies was haemolymph plasma from oak silkworm (or eri silkworm) pupae 33.9 percent, milk 33.9 percent, yolk 25.42 percent, Neisenheimer's salt 6.78 percent. The problem of mass emergence of normal wasps from artificial capsules remains still unsolved.

Utilizing Bracon greeni [= greenei] Ashmead as a Means to Control Eublemma amabilis Moore in the Forests of Lac Production

Lac is a kind of biological shellac which is the product of a secretion of Laccifer [=Kerria] lacca (Kerr) after this insect has been parasitic on certain host plants. During the course of developing lac production in our province, Laccifer lacca was found to be seriously infested by Eublemma amabilis Moore. Since Eublemma can have several generations and the lac-producing areas are concentrated in the mountainous regions, therefore, the control of Eublemma by chemical insecticides and human labor are very expensive. Also, these controls cannot be practical in large areas of lac production.

Through our field survey, we found the braconid parasite, Bracon greeni Ashmead, on Hainan Island. Bracon greeni is a natural enemy of Eublemma amabilis. Braconid parasites form a natural colony under the conditions in Hainan. They effectively inhibit the damage caused by the noctuid Eublemma.

Braconi greeni is a parasite of the larvae of E. amabilis; it can be only parasitic on the proper stage of E. amabilis, normally the second or third instars with a body length more than 3 mm. B. greeni reproduces itself very quickly and there is no diapause phenomenon under the climatic conditions of the Guangdong lac production areas.

At the beginning of 1972, we introduced B. greeni from Hainan Island to Furu (Fu-ju) Lac Farm, Fengshun district.

After B. greeni had been reared five generations indoors, we liberated 478 adult B. greeni (345, 133) into a lac forest area of about 13 mu on this farm. In May 1973, we liberated B. greeni in four other regions of Fengshun district. After the liberation of B. greeni, the average parasitism on E. amabilis was above 50 percent in the first generation of lac insect with more than 60 percent in the successive generations. The density of E. amabilis was reduced from 30 insects per meter of lac stick to a level as low as five insects per meter of lac stick. The production of lac was thus raised from 20 to 40 percent higher, and even double the production, and the lac was of better quality as compared with that of the control area.

After the liberation of B. greeni, it can be naturally dispersed in an area of 1.7 km from the point of liberation in the first lac generation. The farthest point of dispersion of the parasite may reach 7.5 km. In the second generation, B. greeni in the dispersal area had a low percentage of parasitism in the beginning, but the infestation caused by E. amabilis could be controlled within an interval of time.

Hainan Island is the native home of B. greeni where the climate is warm and which has a continuous supply of hosts; however, the lac production area in the mainland usually suffers the effects of cold waves during the winter season. Low temperature and rainfall interrupt the activity of B. greeni. In the mainland lac-producing areas, there are only two seasons of collecting and dispersing of lac insects. After the collection of lac, there is a period in

which there is no proper stage of *E. amabilis* for parasitism on the new lac cover in the forest. *Bracon greeni* thus meets a phase of nutritional stoppage. There are two periods in which the supply of nutrition is stopped within a year. The stopping period in the winter starts from November to March of the next year and the stopping period in summer is in June.

We fully analyzed the various factors in the build-up of the natural colony of *B. greeni* in Hainan. According to the conditions in the Fengshun district, an experiment on artificial supplement of hosts was carried out. The results of that experiment solved the problem of how to keep more *B. greeni* insects in the forest. The artificial supplement of hosts was done by hanging the lac branches having *E. amabilis* at the proper developmental stage in the forest after each collection of lac so that *B. greeni* will parasitize them and deposit eggs for the next generation. *Bracon greeni* can reproduce two to three generations on the supplemental hosts in the winter and one to two generations in the summer period. The winter lac generations (in 1973, 10; in 1974, 5) showed significant results of the use of the above-mentioned method. The experimental plots of supplemented hosts had an average percentage of *B. greeni* parasitism of 54 percent as compared with that in the control of only 7.4 percent. In Fengshun district, Furu, *B. greeni* was liberated in June 1972. There were six lac insect generations within the past 3 years. Adopting the supplement method, the serious infestation caused by *E. amabilis* was effectively controlled not only at the point of liberation but also in the area of dispersion.

The biological control of *E. amabilis* by *B. greeni* has been extended for practical use in every lac production area of Guangdong Province. The cadres and the peasants in this area all consider that this method is convenient, economical and labor-saving.

Culicide Effect of a New Species of *Streptomyces*.

(Guangdong Entomological Institute; Beijing Microbiological Institute, Academia Sinica; Guangdong Hygienic and Anti-Infectuous Disease Station)

Streptomyces No. 7180 is found to be effective for the control of mosquitoes. After having investigated its morphological, physiological, and biochemical features and its cultural characteristics, it is evident that this organism is quite different from those related species so far known. Therefore, it is identified as a new species: *Streptomyces culicidicus* Yan & al. n. sp. The cultural fluid of this organism is active against the larvae of *Anopheles hyrcanus sinensis* W., *Culex fatigans* W. [=*C. pipiens qinquefasciatus* Say], *C. bitaeniorhynchus* Giles, *C. fuscanus* W. and *Armigeres obturbans* W., and others. It is also evident that the cultural fluid from shaking-flask cultivation, after being diluted to 1,000 or 2,000 times, is still quite lethal to larvae of *Culex fatigans*, causing its mortality of over 90 percent.

After induction treatment and continuous selection, a high culicide effect mutant has been obtained. Its culicide effectiveness has been heightened by 40,000- to 60,000-fold as compared with its original culture. The results of outdoor application tests showed a death rate of *C. fatigans* larvae of up to 80 percent or more, by supplying a powder preparation of this mutant with its 50,000 to 70,000 times dilution.

The Migration Zones of the Armyworm (*Mythimna separata*) and the Mathematical Model of its Distribution

Wu Xiang-guang
(Guangdong Institute of Entomology)

Abstract:

1. The armyworm annually migrates horizontally and vertically in the zones covering the plains of eastern China and the plateaus of western China. From winter solstice to summer solstice, from latitudes 19° N to 53° N, it migrates from south to north, from 10 m above sea level upwards to 2500 m; after this period it does vice versa; namely, it remigrates from north to south and from high levels downward. Whenever it migrates to a new zone, it reproduces a new generation; the cycle of each generation, with exceptions, is about 60 days. This paper presents a sketch map illustrating the five zones of its occurrence.

2. The orientation of each migration of the armyworm is the same as the displacement direction of the sun when it is at its summit; and the bases upon which it chooses to land and to carry out egg reproduction (that is, the latitudes of its migration) are related to the solar incident angle during the migration period of its adults. When the sun locates south of the summit and is to pass the meridian, the solar incident angle of a given day may be solved as follows:

$$h\ \theta = \delta 0 - \psi + 90° \qquad (1)$$

Similarly, when the sun locates north of the summit and is to pass the meridian, the solar incident angle of a given day will be:

$$h\ \theta = \psi + 90° - \delta\theta \qquad (2)$$

3. The height and sea level elevation of the vertical migration zone correspond to the latitudes of the horizontal migration zone. When it is in the former half of an annual period, they may be given with following equation:

$$h' - h = T\ (\psi' - \psi) \qquad (3)$$

But, when it is in the latter half, i.e. during the remigration, the locations of ' and in the equation will be reversed as follows:

$$h - h' = T\ (\psi - \psi') \qquad (4)$$

within T =62.9 + 0.74.

4. According to the preceding four mathematical equations, the long-term forecast of the zones where armyworm occurs and distributes can be made.

5. Based on the rhythm of the horizontal and vertical migration and on the calculation with the above predicting equations, it may be conjectured that there might be a sixth possible occurrence zone in other countries. The limits of that occurrence zone are very likely between latitudes 12.8° N and 15.3° N, with a central latitude near to latitude 13.2° N.

Judging by its reckoned sea level elevation, it must be a lowest zone of depression and plain.

THE DEVELOPMENT OF *Trichogramma dendrolimi* IN ARTIFICIAL DIET DROPS

Terms	Average	Max.	Min.
Number of eggs in 1 drop	114.2 ± 32.62	04	97
Duration of egg stage (hr.)	18.0	--	--
Duration of larval stage (hr.)	45.3 ± 4.4	53	40
Number of prepupae in 1 drop	86.1 ± 10.8	96	62
Percent of prepupae	58.5 ± 9.57	73.28	43.63
Duration of prepupal stage (hr.)	86.6 ± 15.9	123	72
Number of pupae in 1 drop	39.0 ± 23.89	87	10
Percent of pupae	45.3 ± 24.84	90.63	12.82
Duration of pupal stage (hr.)	117.6 ± 21.65	166	94
Number of adults from 1 drop	7.1 ± 4.53	15	3
Percent females	91.7 ± 9.66	100	78.6
Number of normal adults from 1 drop	2.3 ± 1.98	5	0
Percent of adults	18.7 ± 6.09	25	2.88
Percent of normal adults	27.9 ± 20.30	66.67	0
Life cycle (hr.)	267.3 ± 39.21	360	243

Diet Ingredients

Yolk 25.41 percent, Milk 25.41 percent,
Haemolymph of oak silkworm pupae 21.78 percent,
NS salt 7.26 percent, Water 20 percent,
Streptomycin 0.15 percent

Rearing, temperature -- 26° to 28° C. Origin of *T. dendrolimi* was Chang Xing, Zhejiang Province.

MAIN CITRUS PESTS OF GUANGDONG PROVINCE

Tortricidae

Adoxophyes cyrtosema Meyrick
Cacoecia eucroca Diakonoff
Cacoecia [= *Archips*] *tabescens* (Meyrick)

Leafminers

Phyllocnistis citrella Stainton (citrus leafminer)

Mites

Panonychus citrus (McGregor) (citrus red mite)
Phyllocoptes [= *Phyllocoptruta*] *oleivorus* Ashmead (citrus rust mite)

Cerambycidae

Anoplophora chinensis (Forster) (citrus trunk borer)
Chelidonium argentatum (Dalman)

Pentatomidae

Rhynchocoris humeralis (Thunberg)

Geometridae

Buzura suppressaira benescripta Prout (tung oil tree geometrid)

Papilionidae

Papilio polytes L. (white-banded swallowtail)
P. demoleus L. (lemon butterfly)
P. xuthus L. (smaller citrus dog)

CHARTS DISPLAYED BY PLANT PROTECTION DEPARTMENT,

SOUTH CHINA AGRICULTURAL COLLEGE, GUANGZHOU,

DURING THE U.S. BIOLOGICAL CONTROL DELEGATION'S VISIT,

JULY 28, 1979

Life Table for Second Generation of Rice Leafroller,

Cnaphalocrocis medinalis, in Guangdong Province (Data Collected 1976-1979)

		100 Sx			
4	dψf	1976	1977	1978	1979
Eggs	*Trichogramma*	66	94.2	73.3	87.4
	Predators and others	54	34.6	63.3	28.4
L_1	Predators and others	88	19.1	62.2	10.5
	Apanteles cypris	--	95.3	98.2	90
L_2	Predators and others	88	45.5	54.4	50
	Apanteles cypris	15.6	77.3	65.3	80
L_3	Predators and others	--	51.5	58.9	60
	Apanteles cypris and *Temelucha philippinensis*	--	82.9	84.9	76.6
L_4	Predators and others	90	69.5	58.7	43.7
	Apanteles ruficrus, *Elasmus* spp., *T. philippinensis*, *A. cypris*	76	66.6	80.8	48.6
L_5	Predators and others	--	70.0	47.8	22.3
	A. ruficrus, *Elasmus* sp., *T. philippinensis*, *Apanteles* sp.	--	--	83.7	70
Pre-pupae	*Elasmus corbetti*	99	--	--	--
Pupae	Predators and others	93	75.2	73.4	37.5
	Brachymeria lasus *B. excarinata* and *Xanthopimpla*	76.4	86.4	79.7	56.7
	Disease	--	--	78.0	--
Adult	P	57	54	54	51
	P	37	52	52	46
$= \frac{N}{No} = S_E \cdot S_L \cdot S_L \cdot S_L \cdot S_L \cdot S_1 \cdot F \cdot P_F \cdot P_o$		0.87	0.067	0.31	0.0014

The Effect of Different Treatments on the Life Table

of *Cnaphalocrosis medinalis*

		100 Sx			
		B H C & E 1605 1/	*Trichogramma* spp.	Check	Note
Eggs	Predators and others	54	54	54	Q_1
	Parasites	66	14	66	Q_2
L_1	Predators and others	10	76	88	Q_3
L_{2-3}	Predators and others	98	76	88	Q_4
	Parasites	93.67	14	15.67	Q_5
L_{4-5}	Predators and others	97	76	90	Q_6
	Parasites	93	64	99	Q_7
Pre-pupae	Parasites	100	98	99	Q_8
Pupae	Predators	96	86	93	Q_9
	Parasites	90.4	63.9	76.4	Q_{10}
	Q_{10}	2.56	0.16	2.07	-
	I	1.08	0.067	0.88	
	$P_{♀} = 0.57$, $F = 200$, $P_F = 0.37$				

1/E 1605 is parathion

LIVE BIOLOGICAL CONTROL MATERIAL OBTAINED BY THE PEPPLE'S REPUBLIC OF CHINA FROM THE UNITED STATES IN 1979

A. Entomogenous Microorganisms 1/

1. Nuclear polyhedrosis virus (NPV) ex Autographa californica

   Received by the PRC delegation in the United States, August 1979, from Pennsylvania State University, State College, Pennsylvania (Dr. W. G. Yendol). For Shanghai Institute of Entomology, Fudan University, Shanghai, and/or Zoological Institute, Beijing.

2. NPV ex Autographa californica (preparation 13)

   Received by the PRC delegation in the United States, September 1979, from USDA Stored-Product Insect Research Laboratory, Fresno, California.

3. NPV ex Heliothis zea

   Received by the PRC delegation in the United States, August 1979, from Pennsylvania State University (Dr. W. G. Yendol). For Shanghai Institute of Entomology, Fudan University, Shanghai, and/or Zoological Institute, Beijing.

4. NPV ex Lymantria dispar

   Received by the PRC delegation in the United States, August 1979, from Pennsylvania State University (Dr. W. G. Yendol). For Shanghai Institute of Entomology, Fudan University, Shanghai, and/or Zoological Institute, Beijing.

5. NPV ex Trichoplusia ni (preparation 12)

   Received by the PRC delegation in the United States, September 1979, from USDA Stored-Product Insect Research Laboratory, Fresno, California.

6. Granulosis virus ex Plodia interpunctella

   Received by the PRC delegation in the United States, September 1979, from USDA Stored-Product Insect Research Laboratory, Fresno, California.

7. Bacillus thuringiensis var. israelensis (BTl) (Abbot experimental preparation)

   Received by the PRC delegation in the United States, September 1979, from University of California (Dr. R. Garcia), Albany, California. For Shanghai Institute of Entomology.

See footnote at end of appendix.

B. Entomophagous Arthropods

1. Chrysopa carnea (Neur.: Chrysopidae)

   Received by the PRC delegation in the United States, September 1979, from USDA Cotton Insects Research Laboratory, College Station, Texas.

2. Trichogramma "pretiosum" (Hym.: Trichogrammatidae)

   Received by the PRC delegation in the United States, September 1979, (as parasitized Sitotroga eggs) from Rincon-Vitova Co., Oak View-Ventura, California.

C. Antagonists, Antibiotics, etc., for Control of Plant Pathogens

1. Trichoderma harzianum T-14 (pelletized culture) (Fungi imperfecti)

   Received by the PRC delegation in the United States, August 1979, from USDA Soilborne Disease Laboratory (G. C. Papavizas), Beltsville, Maryland.
   For study for use against Rhizoctonia diseases.

2. Trichoderma harzianum WT-6 (fresh culture) (Fungi imperfecti)

   Shipped October 25, 1979 [BIIL(SDL)-79-17] from USDA Soilborne Disease Laboratory (G. C. Papavizas), Beltsville, Maryland. Received in good condition at Beijing, November 16, 1979. For study for use against Rhizoctonia diseases.

1/ Does not include material exchanged outside US/PRC biological control exchange agreement, including cultures of Bacillus thuringiensis sent to PRC scientists by Dr. H. T. Dulmage, USDA Cotton Insects Research, Brownsville, Texas: In recent years, Dr. Dulmage has shipped or given B. thuringiensis cultures HD-1, HD-73, and HD-173, to PRC scientists.

BIOLOGICAL CONTROL AGENTS EXCHANGED BETWEEN THE USA AND PRC IN 1980

Received by USA

A. Entomophagous Arthropods

1. Anastatus sp. (Hym.: Bupelmidae)

   Received by U.S. delegation (A. N. Sparks) in the People's Republic of China, July 1980 (as parasitized Antheraea pernyi eggs) from Guangdong Academy of Agricultural Sciences, Guangzhou (Liu Zhicheng). Original host: Tessaratoma papillosa. Received by USDA Stoneville Research Quarantine Facility, Stoneville, Mississippi (W. H. Jones). Cultured for laboratory (host range) study

2. Trichogramma ostriniae (Hym.: Trichogrammatidae

   Received by U.S. delegation (A. N. Sparks) in the People's Republic of China, August 1980 (as parasitized Co^{60} treated Corcyra cephalonica eggs) from Beijing Institute of Agricultural Sciences, Beijing (Shu Yong). Original host: Ostrinia sp. Cultures sent to USDA Cotton Insects Research Unit, College Station, Texas (J. R. Ables), USDA Bioenvironmental Insect Control Laboratory, Stoneville, Mississippi (L. C. Saucier) and University of Minnesota, St. Paul, Minnesota (H. C. Chiang).

3. Propylaea japonica (Col.: Coccinellidae)

   Collected by U.S. delegation (J. R. Ables, R. L. Jones and A. N. Sparks) in cotton, corn and sorghum, in Changcha, Hunan Province, and Gongzhuling, Jilin Province, July 1980. Material sent to USDA Cotton Insects Research Unit, College Station, Texas (J. R. Ables) for culture.

4. Chrysopa sp. (Neur.: Neuroptera)

   Collected by U.S. delegation (J. R. Ables) in the the People's Republic of China, July 1980. Material sent to USDA Cotton Insects Research Unit, College Station, Texas (J. R. Ables) for culture.

5. Macrocentrus grandii (Hym.: Braconidae)

   Collected by U.S. delegation (J. R. Ables) from Ostrinia sp. in Mijun County, Beijing, Muncipality, July 1980. Material sent to University of Minnesota, St. Paul (H. C. Chiang, R. L. Jones)

6. Aphytis lingnanensis (Hym.: Aphelinidae)

   Collected from Aonidiella aurantii by Dr. Paul DeBach in Guangzhou area, Guangdong Province, September 1980. Material sent to University of California, Riverside, for culture.

7. Aspidiotiphagus sp. nr. citrinus (Hym.: Aphelinidae)

   Collected from Aonidiella aurantii by Dr. Paul DeBach in Guangzhou area, Guangdong Province, September 1980. Material sent to University of California, Riverside, for culture.

8. Physcus sp. (Hym.: Aphelinidae)

   Collect from Aonidiella citrina by Dr. Paul DeBach in Chongqing (Chungking), Sichuan Province, September 1980. Material sent to Uniersity of California, Riverside, for culture.

9. Aphytis sp. (near A. melinus or A. fisheri (Hym.: Aphelinidae)

   Received by Dr. Paul DeBach, University of California, Riverside, October 1980, from Citrus Research Institute, Chinese Academy of Agricultural Sciences, Chongqing (Chungking), Sichuan Province (Yu Zhiren). Original host: Aonidiella citrina.

10. Parasitized citrus scales [Aonidiella aurantii]

   Received (two shipments) by Dr. Paul DeBach, University of California, Riverside, from Guangxi Citrus Research Institute, Guilin (Du Yuancheng), October 1980.

B. Entomogenous Microorganisms

1. Nuclear polyhedrosis virus (NPV) ex Lymantria dispar (dead infected larvae

   Received by U.S. delegation (A. N. Sparks) in the People's Republic of China, August 1980, from Northeastern Forestry College, Harbin, Heilongjiang Province, (Yo Shuguai). Material sent to Pennsylvania State University (W. G. Yendol).

2. Beauveria bassiana (Fungi Imperfecti) (sand culture originally isolated from Ostrinia sp.)

   Received by U.S. delegation (A. N. Sparks) in the People's Republic of China, August 1980, from Jilin Academy of Agricultural Science, Gongzhuling, Jilin (Xu Qingfeng). Material sent to USDA Insect Pathology Research Unit, Ithaca New York (R. S. Soper), for culture.

3. Hirsutella thompsoni (Fungi Imperfecti) (sand cultures originally isolated from Phyllocoptruta oleivora)

   Received (2 shipments) by C. W. McCoy, University of Florida, Lake Alfred, Florida, June and December 1980, from Citrus Research Institute, Zhejiang Academy of Agricultural Sciences, Huangyan County, Zhejiang Province.

Received by the People's Republic of China

A. Entomophagous Arthropods

1. *Lixophaga diatraeae* (Dipt.: Tachinidae)

   Received by Liu Zhicheng, Guangdong Academy of Agricultural Sciences, Guangzhou, July 1980, from USDA's Bioenvironmental Insect Control Research Laboratory, Stoneville, Mississippi. Hand-carried to the People's Republic of China by U.S. delegation (A. N. Sparks).

2. *Chrysopa carnea* (Neur.: Chrysopidae)

   Received by PRC delegation (Bao Jianzhang) in the United States, August 1980, from the University of California, Berkeley (K. S. Hagen).

3. *Xylocoris flavipes* (Hem.: Anthocoridae)

   Received by Yao Kang, Huazhong (Central China) Agricultural College, Wuhan, Hubei Province, September 1980, from USDA Stored-produced Insect Research and Development Laboratory, Savannah, Georgia (R. T. Arbogast). Hand-carried to the People's Republic of China by U.S. delegation (P. M. Marsh).

B. Entomogenous Microorganisms

1. Granulosis virus (GV) ex *Cydia pomonella*

   Received by Xu Qingfeng, Jilin Academy of Agricultural Sciences, Gongzhuling, Jilin, From University of California, Riverside (B. Federici). Hand-carried to the People's Republic of China by Dr. Paul DeBach, August 1980.

2. *Hirsutella thompsoni* (Fungi Imperfecti) (originally isolated from *Phyllocoptruta oleivora*)

   Received by Citrus Research Institute, Zhejiang Academy of Agricultural Sciences, Huangyan County, Zhejiang Province, January 1980, from C. W. McCoy, University of Florida, Lake Alfred, Florida.

C. Nematodes

1. *Neoplectana carpocapsae* (Rhabditida: Steinernematidae) (Breton strain)

   Received by Li Liying, Guangdong Institute of Entomology, October, 1980, from University of California, Davis. Hand-carried to the People's Republic of China by H. K. Kaya.

2. *Heterorhabditis heliothidis* (Rhabdita: Heterorhabditidae)
   Received by Li Liying, Guangdong Institute of Entomology, October, 1980, from University of California, Davis. Hand-carried to the People's Republic of China by H. K. Kaya.

PROCEDURES FOR IMPORTATION OF BIOLOGICAL CONTROL MATERIAL INTO THE PEOPLE'S REPUBLIC OF CHINA

The Ministry of Agriculture and the Chinese Academy of Agricultural Sciences (CAAS) both had an interest in exchanging natural enemies of pests. However, the Biological Control Laboratory of the CAAS had the lead role, and Dr. Qiu Shibang, Professor of Entomology at the CAAS, handled the details of importation for the Academy.

The proposed procedures for introducing living natural enemies of pests from abroad into the People's Republic of China were as follows: Permissions for importation were to be obtained by Chinese scientists from the Central Division of Quarantine of the Ministry of Agriculture. Requests from scientists throughout the People's Republic of China were to be sent to the Biological Control Laboratory of the CAAS for approval. After approval was granted, the Central Division of Quarantine of the Ministry of Agriculture or the Quarantine Station in Guangzhou (Canton) was to issue a certificate for importation. Insects were to be sent either to Beijing or to Guangzhou, and, from these locations, to a central location for quarantine containment.

As the People's Republic of China currently lacked adequate quarantine facilities, and the development of a central quarantine containment facility for biological control importations was a time-consuming venture, interim procedures for importation had been established as follows:

1. Only material under laboratory culture, known to be free of hyperparasites or host materials, or field-collected material in the stage that was free of potential contamination (that is, as adults or other stages known to be free of hyperparasities) could be imported into the People's Republic of China. This was to provide safeguards against accidental entry of host or secondary parasite material.

2. All materials were to be sent to the Biological Control Laboratory of the CAAS unless the permit label stated otherwise.

3. PRC quarantine regulations prohibited the entry of certain materials into the People's Republic of China. These are listed in Appendix 7 and should never be included in any shipment of natural enemies to the People's Republic of China.

The importation of microorganisms for biological control would be dealt with on a case-by-case basis.

DETAILED ITINERARY OF THE U.S. BIOLOGICAL CONTROL DELEGATION, WITH NAMES OF PERSONS MET

Monday, July 2, 1979. Washington, D.C.

0930-1600 Briefing at South Building, U.S. Department of Agriculture, Washington, D.C. Persons in attendance included the following:

U.S. Biological Control Delegation
Office of International Cooperation and Development (OICD), USDA
R. E. Neetz, Deputy Director, Science and Technology Exchange
M. S. Campbell
M. Y. Kaupinnen

Economics, Statistics, and Cooperatives Service, USDA
F. M. Surls

Tuesday, July 3, 1979. Enroute

1000 Departed Washington (Dulles International Airport) for Tokyo via Chicago

Wednesday, July 4, 1979. Enroute

1945 Arrived Tokyo, after crossing International Date Line

Thursday, July 5, 1979. Arrival in Beijing

1245 Departed Tokyo

1615 Arrived Beijing by Air France flight 179. Met at Beijing airport by the following PRC officials:

Ministry of Agriculture
Lao Chengzhi, Head, Division of Prevention and Control of Pests, Plant Protection Bureau
Li Yuchuan, Staff Member, Division of Prevention and Control of Pests, Plant Protection Bureau
Huang Yongning, Staff Member, Foreign Affairs Bureau
Zhang Jinhui, Interpreter, Foreign Affairs Bureau (who was to be interpreter for the U.S. delegation throughout the trip)

Beijing Agricultural University
Qiu Weifang (Ch'iu Wei-fang), Professor of Phytopathology
Yan Yuhua (Yen Yü-hua), Specialist in Entomology (who was to be escort for the U.S. delegation throughout its trip)
Zhou Guanyuan, Secretary to the President

Thursday, July 5, 1979 (cont.)

Other
Zhu Hongfu, Professor of Entomology, Institute of Zoology, Chinese Academy of Sciences (CAS)
Qiu Shibang (Ch'iu Shih-pang), Professor of Entomology, Chinese Academy of Agricultural Sciences (CAAS)
Jiang Zhongxie (Chiang Chung Hsieh), Teacher of Entomology, Henan Agricultural College (Dr. H. C. Chiang's cousin, who was to accompany the U.S. delegation for most of its trip)

1900 Dinner and briefing at Hotel Peking with William Davis, U.S. Agricultural Counselor, and John Patrick, Assistant Agricultural Attaché, U.S. Embassy, Beijing

Friday, July 6, 1979. Beijing

0900 General briefing session by the PRC Ministry of Agriculture, Hotel Peking, Beijing. The following persons were present at the briefing:

Ministry of Agriculture
Lao Chengzhi, Head, Division of Prevention and Control of Pests, Plant Protection Bureau
Ceng Zhaohui, Plant Pathologist, Plant Protection Bureau
Huang Yongning, Bureau of Foreign Affairs
Zhang Jinhui, Bureau of Foreign Affairs, who was to serve as interpreter for the U.S. delegation throughout its visit in the People's Republic of China

Others
Qiu Shibang, Professor of Entomology, Chief, Biological Control Laboratory, Chinese Academy of Agricultural Sciences (CAAS)
Zhao Xiufu (Chao Hsiu-fu), Professor of Entomology, Director, Department of Plant Protection, Fujian Agricultural College
Yan Yuhua, Specialist in Entomology, Beijing Agricultural University, who was to serve as escort for the U.S. delegation throughout its visit in the People's Republic of China
John Patrick, U.S. Assistant Agricultural Attache

1400 Visit to the Institute of Zoology, Chinese Academy of Sciences, Beijing. The following persons were met during the course of discussions:
Ma Shichun (Ma Shih-chun), Head, Division of Insect Ecology
Qin Junde (Ch'in Chun-te), Head, Division of Insect Physiology
Zhuo(?) Hean ("Zho" Ho-an), Research Scientist (pesticide metabolism)
He Xiaowei (Ho Hsaio-wei), Research Scientist (insect vision)
Chua Chenghua, Chemist (insect pheromones)
Leng Shanfu
Ren Gaixin, Insect Pathologist
Liao Dingxi, Insect Taxonomist (Chalcidoidea)
Meng Xiangling, Chief, Department of Research Planning
Xiao Wu, Interpreter

Saturday, July 7, 1979. Beijing

1900 Welcoming Banquet, Beijing. Host: Pei Wen, Deputy Director, Plant Protection Bureau, PRC Ministry of Agriculture. Others present (see above) were:
Lao Chengzhi, Huang Yongning, Ceng Zhaohui, Zhang Jinhui, Li Yuchuan, Qiu Shibang, Zhao Xiufu

0800 Visit to the Trichogramma Laboratory, Beijing Academy of Agricultural Sciences (BAAS), Beijing. Persons met included:
Zhang Zhili, Leader of Pest Control
Zhu Yong, Deputy Leader
Wang Yanming, Researcher in Biological Control
Chen Zhaoxiong

1000 Visit to the Biological Control Laboratory, Chinese Academy of Agricultural Sciences (CAAS), Beijing. Persons met included:
He Guangwen, Vice President of the Chinese Academy of Agricultural Sciences
Qiu Shibang, Chief, Biological Control Laboratory
Bao Jianzhang, Associate Research Fellow, Deputy Laboratory Chief
Shen Jinpu, Director, Foreign Affairs Service, CAAS; Plant Pathologist.
Tian Yuqi, Plant Protection Scientist
Zhou Zhenhuan, Agronomist, Foreign Affairs Service, CAAS
Qin Yutian, Interpreter

1300 Visit to Laboratory for Radiation Sterilization for Control of Corn Borer, Institute for Application of Atomic Energy in Agriculture, CAAS. Persons met included:
Xu Guanren (Hsü Kuan-jen), Head, Institute for Application of Atomic Energy in Agriculture (CAAS), and President, Society of Nuclear-Agricultural Sciences
Zhang Heqing, Head, Laboratory for Radiation Sterility for Control of Corn Borer
Zhou Darong, Research Worker (corn borer artificial diet and rearing techniques)

1300 Visit (Drs. Cook and Hagen only) to the Agricultural Antibiotics Laboratory, CAAS. Persons met included:
Yin Shenyun, Head, Agricultural Antibiotics Laboratory
Lian Jiansi (Lien Chien-szu, Lecturer (plant disease control)
Lin Dexing, Lecturer (plant disease control)

Sunday, July 8, 1979. Beijing Municipality

0800-1600 Visit to Biological Control Experiment Station, Miyun County, Beijing Muncipality; and Reception Lunch. Persons met included:
Yang Yuming, Chief of Miyun County Agricultural and Forestry Bureau
Li Renming (Li Jen-ming), Head, Biological Control Experiment Station
Wang Yuling, In Charge of the Station's Trichogramma production
Li Yuchuan, Staff Member, Municipal Bureau of Plant Protection

Sunday, July 8, 1979 (cont.)

1900 Drs. Chiang and Cook attended an informal banquet with the following persons:

Yang Xiantong (Yang Hsien-tung), Vice Minister of Agriculture; President, Chinese Association of Agricultural Sciences (parent society of the Society of Plant Protection)

Shen Jiyi (Shen Chi-yi), Vice President, Beijing Agricultural University

Zhu Hongfu (Chu Hung-fu), Deputy Director, Institute of Zoology, CAS

Xiao Ganrou (Hsiao Kan-jou), Deputy Director, Institute of Forest Protection, Chinese Academy of Forestry

Qui(?) Xifan (Chiu Hsi-fan), Professor of Plant Pathology, Beijing Agricultural University; Vice President of the Chinese Society of Plant Protection

Ke Chang, Plant Pathologist, Member of PRC delegation to IX International Congress of Plant Protection

Tuesday, July 10, 1979. Beijing

0900 Discussion of the US/PRC Biological Control Exchange Program, Hotel Peking, Beijing. Persons attending were the same as those attending the briefing session of July 6, with the addition of:

Jin Liang, Plant Protection Specialist and Deputy Chief, Plant Protection Division, Agricultural Bureau of Hubei Province, Wuhan (who was to be a member of the Chinese Biological Control Delegation to the United States)

1400 Revisit to the Institute of Zoology, CAS, Beijing. Persons met included:

Chen Teming, Head, Laboratory of Insect Hormones

Meng Xiangling, Chief, Department of Research Planning

Wu Yanru (Wu Yen-ju), Taxonomist, Department of Taxonomy and Faunology

Ren Gaixin, Insect Pathologist

1400 Visit (Dr. Cook only) to Institute of Microbiology, CAS. Persons met included:

Tian Bo (Tien Po), Plant Virologist

Wang Xiaofeng (Wang Hsiao-feng), Plant Virologist

Liang Penyan, Plant Virologist

Wang Jigai (Wang Chi-kai), Plant Virologist

Zheng Ruyong, Head, Mycology Laboratory

Lin Xieyin, Mycologist

Zhen Gengtao(?) (Chen Keng-t'ao; K. T. Chen), Mycologist

Zhen Jiti(?) (Chen Chi-ti), Mycologist

Guo Yinglan, Research Assistant

2235 Departed Beijing by train (no. 171) for Jilin Province

Wednesday, July 11, 1979. Tonghua Region, Jilin Province

1600 Arrived at Railway Station, Meihekou, Tonghua Region, Jilin Province. Met by following officials:
- Shi Yuzhen, Deputy Director, Plant Protection Division, Jilin Province Agricultural Bureau
- An Yupei, Deputy Director, Tonghua Region Bureau of Foreign Affairs
- Yao Wanxing, Chairman, Liuhe County Revolutionary Committee
- Zhu Taichang, Director, Liuhe County Agricultural Bureau
- Wang Feishen, Staff Member, Foreign Affairs Office, Liuhe County Agricultural Bureau

1800 Arrived at Liuhe, Liuhe County, Tonghua Region, accompanied by the above persons, and met by the following additional persons:
- Zhang Benxi, Director, Liuhe County Biological Control Experiment Station
- Song Muqian (Sung Mu-ch'ien), Station Deputy Director
- Wang Yubin, Deputy Chairman, Liuhe County Revolutionary Committee

1900 Reception dinner at Liuhe County Guest House, hosted by Shi Yuzhen and attended by all others listed above

Thursday, July 12, 1979. Tonghua Region, Jilin Province

0800 Visit to the Biological Control Experiment Station, Liuhe County, Tonghua Region, Jilin Province. Persons present during discussions were:
- Zhu Taichang, Director, Liuhe County Agricultural Bureau
- Wang Yubin, Deputy Chairman, Liuhe County Revolutionary Committee
- Zhang Benxi, Director, Biological Control Experiment Station
- Song Muqian, Station Deputy Director, and in charge of the Station's *Trichogramma* program

1300 Visit to the Oak Silkworm Production Station, Liuhe County. Persons met or present during discussions were:
- Hu Liangde, Station Director
- Zhang Jin, Technician, in charge of rearing oak silkworms
- An Yupei, Zhu Taichang, and Yao Wanxing, whom we had met July 11

1430 Visit to a Brigade of Liu Shuchen Township, Liuhe County. Met Liu Jiafang, Brigade Plant Protection Specialist

1900 Seminar by Dr. King, and culture movies at Liuhe County Guest House

Friday, July 13, 1979. Changchun, Jilin Province

0030 Departed Liuhe for Changchun by train. Accompanied by Shi Yuzhen and Wang Feishen (whom we had met July 11)

0845 Arrived at Changchun, Jilin Province

Friday, July 13, 1979 (cont.)

1445 Visit to Changchun Institute of Applied Chemistry, CAS. Persons met during discussions were1/:

Wu Yu, Professor, Institute Deputy Director
Chu [or Zhu?] Tianpei, Coordinator of the Scientific Project Department
Shen Lianfang, Deputy Head, Laboratory of Structural Chemistry
Wang Fusong, Professor, Synthetic High Polymers Laboratory
Mo Zisun (Mo Tzusun), Professor, X-ray Diffractometry Laboratory
Wang Erkang, Head, and Chuang Yanhua, Researcher, Polarographic Analysis Laboratory
Yu Fusen, Professor and Head, and Jin Shabin, Interpreter, Physical Properties of High Polymers Laboratory
Jiang Yijin (Chiang Yi-jin), Head, Chen Yiyi, Researcher, and Pei Fengkui, Interpreter, NMR Spectroscopy Laboratory
Chu Yufeng, Head, GC-Mass Spectroscopy Laboratory (structure identification of the sex attractant of the pine caterpillar)
Chang Ji, Researcher of the above Laboratory (separation and identification of the sex attractant of the corn borer)
Wang Renpin, Researcher, and Xi Shichuan (Hsi Shi-chuan), Interpreter, of the above Laboratory (application of the GC-MS in environmental analysis)

1900 Reception dinner hosted by Hui Liangyu, Deputy Director of the Jilin Province Bureau of Agriculture. Others attending included:

Chen Yeze, Staff Member, Office of Foreign Affairs, Jilin Province Bureau of Agriculture
Chen Hangbu, Interpreter, Changchun Foreign Affairs Office
Shi Yuzhen and Wang Feishen (whom we had met July 11)

Saturday, July 14, 1979. Changchun Municipality, Jilin Province

0800 Visit to Jilin Forestry Research Institute. Persons met during discussions included:

Guo Shouqian, Institute Deputy Director
Chen Engu, Institute Deputy Director
He Pingxing, Deputy Chief, Forestry Protection Division
Wu Yuqian, Head, Sciences and Technology Section
Yu Enyi, Leader, Biological Control Division

1300 "Technical Session" at Changchun Hotel, Changchun. The following organizations were represented at this session (also given is an unfortunately incomplete list of only those persons not met previously):

1/ Spellings of the names listed here are mostly those given to the delegation, and some may be a mixture of old and new spellings or otherwise in error.

Saturday, July 14, 1979 (cont.)

Liuhe County Biological Control Experiment Station, Liuhe
Plant Protection Institute, Jilin Academy of Agricultural Sciences, Huaide (Gongzhuling)
Xu Qingfeng (Hsu Ch'ingfeng), Insect Pathologist
Wang Chenglun, Entomologist (*Trichogramma*)
Pai Jinkai (Pai Chin-kai), Plant Pathologist
Applied Chemistry Research Institute, CAS, Changchun
Biological Control Division, Jilin Forestry Research Institute, Changchun Municipality
Plant Protection Group, Vegetable Research Institute of Jilin Province, Changchun
Lou Xichen, Entomologist
Yang Chenlin, Plant Pathologist
Division of Plant Protection, Jiling Agricultural Bureau [= Changchun Agricultural Institute?], Changchun
Yue Chongdai, Plant Pathologist2/
Changchun City Plant Protection Station
Jilin Agricultural University
Wang Zhipian, Professor of Plant Pathology

2000 Movies: (1) Biological Control of Pink Bollworm in Cotton Boll Storage Bins by Augmentative Releases of *Dibrachys cavus*; and (2) Conservation of Frogs in Rice Paddies for Biological Control of Insect Pests

Sunday, July 15, 1979. Jilin and Liaoning Provinces

0800 Field collection trip in Huaide County, Siping Region, south of Changchun. Hosts for this visit were:
Chen Yeze, Office of Foreign Affairs, Jilin Bureau of Agriculture
Li Huazhong, Office of Foreign Affairs, Huaide County
Guo Shuchao, Leader, Paozeyuan Brigade, Fangxiang Commune, Huaide County

1320 Departed Changchun for Shenyang (Mukden) by train

1745 Arrived Shenyang, Liaoning Province. Met by Mr. Li3/, Head, and Mr. Ning Kecheng, Deputy Head, Plant Protection Division, Liaoning Province Bureau of Agriculture

2300 Departed Shenyang for Suzhou, Jiangsu Province, by train

Monday, July 16, 1979. Enroute to Suzhou by train

2/ Mr. Yue's affiliation is unclear. Dr. Cook's notes give it as Jiling Plant Protection "Institute," but not the Institute at Gongzhuling; he may be from Jiling Agricultural Bureau's Plant Protection Division.

3/ Mr. Li's full name was unfortunately not recorded by Delegation members.

Tuesday, July 17, 1979. Suzhou Region, Jiangsu Province

0450 Arrived at Suzhou, Suzhou Region, Jiangsu Province. Met by following persons:
- Yang Shanfa, Head, Plant Protection Division, Suzhou Region Agricultural Bureau
- Xi Jin, Foreign Affairs Office, Suzhou Region Agricultural Bureau

0900 Visit to the "Plant Protection Station" of the Wu County (Wuxian or Wuhsien) Institute of Agriculture, Suzhou Region.[4/] Persons present during discussions were:
- Shi Taifu, Institute Director
- Pan Guoxin, Head, "Plant Protection Station"
- Chen Gongxian, Leader, Plant Protection Group
- Jiang Hanchen, Technician, Plant Protection Group
- Zhuang Guanyan, Staff Member, Wu County Foreign Affairs Office

1930 Reception dinner hosted by Huang Chuntu, Deputy Director of Suzhou Region Bureau of Agriculture, and attended by Yang Shanfa and Xi Jin

2100 Discussion of plant disease control in Suzhou Region between Dr. Cook and Yang Shanfa, Head of Plant Protection Division, Suzhou Region Agricultural Bureau

Wednesday, July 18, 1979. Suzhou Region, Jiangsu Province

0745 Visit to the Changshu County Pest Monitoring and Forecasting Station. Persons present during discussions included:
- Gu Liang, Deputy Director, Changshu County Agricultural Bureau
- Qian Weichun (or Weiqin?), Station Director
- Sun Yunxiang, Station Deputy Director
- Xi Yanlin, Staff Member, Changshu County Foreign Affairs Office

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4/ There is some uncertainty as to both the title and the administrative level of this organization. During our visit it was variously called Wuxian (County) Institute of Agriculture and Wuxian (County) Academy of Agricultural Sciences. Our itinerary, given to us in Beijing, scheduled us for a visit to the Suzhou (Region) Institute of Agricultural Sciences (?= Suzhou Academy of Agricultural Sciences). There is also some question as to whether Mr. Shi Taifu is Director of the institute (or academy) and/or of the Wuxian (County) Agricultural Bureau. The station, though called a plant protection station, encompassed research other than on plant protection, and may have been the main or only institute station, of which Mr. Pan Guoxin was Director.

Wednesday, July 18, 1979 (cont.)

1030 Visit to Jinkuan (Chin-k'uan) Antibiotics Production Plant. Persons present during discussions included:
Hang Yunkang, Deputy Chairman of the Plant
Wang Weiqian, Zhou Suxian, Zhu Yunfu, Zuo Yunguang, and Zhang Xijin, Technicians and Workers
Gu Liang, Qian Weichun, and Xi Yanlin, whom we had met earlier in tne morning (see above)

1400 Visit to Zhi Dang Commune, 1st Brigade, No. 10 Production Team (by Drs. Chiang, Hagen, King, and Mr. Coulson). Persons present during discussions included:
Tao Guanqin, Team Leader, No. 10 Production Team
Zhou Dide, Deputy Team Leader
Ca Tianbu and Tian Jinyan, Technicians
Visit to Bai Mao Commune, Microbiological Plant (by Drs. Cook, Klassen and Yendol). Persons present during discussions included:
Qian Zhichun, Leader of the Microbial Group of the Commune
Kong Yangyan, Head of Microbial Production for the Commune
Pu Tianshan, Deputy Chairman, Revolutionary Committee of Bai Mao Commune
Hu He, Technician, Plant Protection Division, Changshu County Agricultural Bureau

1600 Visit to the Taicang ("Taichung") County Agricultural Bureau's Pest Monitoring and Forecasting Station. Persons present during discussions included:
Zhu Hanggou, Deputy Director, Taicang County Agricultural Bureau
Jin Chunliang, Deputy Head, Office of the Taicang County Revolutionary Committee
Pu Mouhua, Head, Pest Monitoring and Forecasting Station
Chen Jiahun, Technician of the Station

Thursday, July 19, 1979. Suzhou Region, Jiangsu Province, and Shanghai

0745 Collection trip to Dongting Mountain, Dong Ting Commune. Met Yang Jaiji, Horticultural Technician of the Commune

1800 Departed Suzhou by train

1905 Arrived Shanghai. Met by the following persons:
You Qinghong (Yu Ching Hung), Deputy Director, Plant Protection Institute, Shanghai Municipal Academy of Agricultural Sciences
Wu [or Hu?] Shichang and Zhang Gengqiao (Chang Keng-chiao), Assistant Research Fellows of this Institute
Liu Qi, Interpreter, Shanghai Municipal Academy of Agricultural Sciences

Friday, July 20, 1979. Shanghai

0800 Visit to Department of Biology, Fudan University. Persons met or present during discussions included:
- Zhang Daoli, Professor, Deputy Head, Department of Biology
- Xin Jieliu (Shin Kai-lou), Professor of Entomology
- Liang Lairong, Entomology Instructor
- Lu Shanzhen, Biology Instructor
- Le Yunxian, Insect Pathologist
- You Shanjian (Yu Shan-chien), Plant Virologist
- Zhang Huohua, Staff Member of the University's Foreign Affairs Office
- Ro Yanxuan, Entomology Technician (pathology)
- Ke Lisheng and Dong Huiching, Graduate Students
- Fu Yaofang, Interpreter
- You Qinghong, Wu [or Hu?] Shichang, Zhang Gengqiao, and Liu Qi, of the Shanghai Academy of Sciences, whom we had met the previous evening

1400 Visit to the Shanghai Institute of Biochemistry, Chinese Academy of Sciences. Persons met during the visit included:
- Cao Tianjin (Tsao Tien Chin), Institute Deputy Director
- Sun Yukun (Sun Yu-kun), Associate Research Fellow in Insect Virology
- Xu Jiansen (Hsu Ting-seng), Associate Research Fellow in Insect Biochemistry
- Xiong Limin (Hsiung Li-min), Assistant Research Fellow in Plant Virology
- Xi Weigen, Assistant Research Fellow in Plant Virology
- Zen Yisheng, Assistant Research Fellow
- Chen Yuanzhong (Chen Yuan-chung), Researcher on Neurotoxins

1930 Welcoming Banquet, Shanghai. Host: Chu Xin, Vice President of the Shanghai Academy of Agricultural Sciences. Others present included other members of the Academy met earlier, and Xu Jiansen from the Biochemistry Institute.

Saturday, July 21, 1979. Shanghai

0800 Visit to Shanghai Microbiological Plant for Production of *Bacillus thuringiensis*, West Suburb Park. Discussions were held with:
- Shang Zhangjian, Plant Director and Vice-Chairman of the Park
- Yao Duanliang, Deputy Director, Plant Technician

1045 Visit to the Shanghai Institute of Entomology, Chinese Academy of Sciences. Persons met during the visit included:
- Yang Pinglan (Young Bain-ley), Institute Director
- Liu Weite, Institute Deputy Director and Chief, Insect Toxicology Laboratory
- Zhu Guokai (Chu Kuo-k'ai), Chief, Insect Virology Laboratory
- Cuo Meising (Ts'o Mei-sing), Chief, Insect Physiology Laboratory
- Du Jiawei, Deputy Chief, Laboratory of Experimental Technology
- Xia Kailing (Hsia K'ai-ling), Chief, Insect Taxonomy and Ecology Laboratory

Saturday, July 21, 1979 (cont.)

Luo Zhiyi (Luo Chih-yi) and She Dasen, Ecology Research Workers, Insect Taxonomy and Ecology Laboratory
Li Wengan, Research Worker, Laboratory of Experimental Technology
Jin Qinying (Chin Ch'in-ying), Curator of Institute's Insect Collection
Yin Wenying, Taxonomist, Insect Taxonomy and Ecology Laboratory
Zhu Xianghong, Research Worker, Insect Physiology Laboratory
Cheng Chung Ching, Indonesian Research Worker of the Insect Physiology Laboratory

1530 Visit to the Shanghai Institute of Organic Chemistry, Chinese Academy of Sciences. Persons met during discussions included:
Yao Jiexin, Institute Deputy Director
Zhou Weishan, Laboratory Chief
Lin Guojiang (Ling Chao-chang), Research Worker, Insect Hormone Laboratory

1930 "Technical Session" at Jing Jiang (Ching Chiang) Hotel, Shanghai. Organizations represented at this session included the following (an unfortunately incomplete list of only those persons not met at previous visits is also given here):
Department of Biology, Fudan University
Shanghai Institute of Biochemistry
Shanghai Institute of Entomology
Shanghai Institute of Plant Physiology, CAS
Song Hongyu, Microbiologist, Specialist in Biological Nitrogen Fixation
Wang Yinjiang, Researcher, Department of Plant Hormones
Shanghai Academy of Agricultural Sciences

Sunday, July 22, 1979, Shanghai Municipality

0800 Shanghai Botanical Garden

1400 Visit to Bei Qiao Commune. Persons met included:
Lao Shengchang, Secretary of the Commune
Dong Huolin, Deputy Director of the Commune's Agricultural Research Institute

1830 Meeting (Dr. Cook only) with members of Shanghai Institute of Agricultural Chemicals, CAAS, at Hotel:
Sheng Yingchu, Microbiologist
Wu Yijun, Microbiologist

Monday, July 23, 1979. Hangzhou, Zhejiang Province

0745 Departed Shanghai by air

Monday, July 23, 1979 (cont.)

0815 Arrived Hangzhou. Met at airport by the following persons:
- Jiang Yumin, Director, Business Office, Zhejiang Academy of Agricultural Sciences
- Xu Zhongan, Secretary, Business Office, Zhejiang Academy of Agricultural Sciences
- Hu Cui, Entomologist, Plant Protection Department, Zhejiang Agricultural University

0915 Visit to Xi Hu (West Lake) by boat to discuss local itinerary with above listed persons

1500 Visit to Zhejiang Academy of Agricultural Sciences (ZAAS). The following persons were met during the course of the visit:
- Chen Chuanren, Deputy Director, Plant Protection Institute
- Lin Kaijiang, Deputy Director, Microbiology Institute
- Huang Wencai, Chief, Agricultural Antibiotics Laboratory, Microbiology Institute
- Guo [or Gao?] Wenbin, Agronomist, Pest Control Researcher
- Wu Guolue, Assistant Research Fellow, Entomology Laboratory, Plant Protection Institute
- Fang Qilian, Vegetable Researcher, Horticultural Institute
- Mian ______ [?; name not recorded in full], Antibiotics Researcher
- Jiang Yumin and Xu Zhongan, met earlier, were also present

1930 Welcoming Banquet, Hangzhou. Host: Wu Benzhong, Vice President of the Zhejiang Academy of Agricultural Sciences

Tuesday, July 24, 1979. Hangzhou, Zhejiang Province

0800 Visit to Plant Protection Department, Zhejiang Agricultural University. The following persons were met during the course of the visit:
- Chu Tianxiang (Chu T. T.), Acting Department Head, and Professor, Agricultural Pests
- Chen Xu (Chen S.), Professor, Integrated Control of Rice Insects
- Li Xueliu (Lee H. L.), Professor, Biological Control of Mulberry Pests, Identification of Beneficial Insects
- Tang Jiao (Tang C.), Professor, Study of gall aphids of *Rhus* (sumac) for tannin production (for ink, etc.)
- Jiang Zhentong (Tsiang Chen-tung), Professor, Plant Pathology (bacterial blight of rice)
- Ge Qixin (Ko C. S.), Professor, Taxonomy of Fungi
- Chen Huangkuai (Chen H. K.), Professor, *Fusarium* Taxonomy
- Li Debao (Li Te-Pao), Plant Virologist
- Le Guanchen, Plant Pathologist
- Wang Guangchen, Researcher, Taxonomy of Fungi
- Chen Heshen, Bacteriologist
- Hu Cui, Lecturer, Biological Control of Insects
- Liu Shushen, Research Assistant (student of biological control, studying under Hu Cui)
- Zhu Ruzuo, Professor, Taxonomy of Beneficial Insects

Wednesday, July 25, 1979. Hangzhou, Zhejiang Province.

0800 Informal discussion with Mr. Yan Yuhua, the Delegation escort, concerning the PRC Survey of Natural Enemies of Agricultural Pests

0830 Visit to the Tea Research Institute, CAAS. The following persons were met during the visit:
- Zhou Jiuzhen, Institute Deputy Secretary
- Li Lianbiao, Chief, Tea Culture Division
- Hu Haibo, Deputy Chief, Tea Culture Division
- Chen Zenshi, Chief, Tea Machinery Division
- Yan Yuchen, Chief, Tea Physiology and Biochemistry Research Division
- Xi Zhenbin, Chief, Tea Processing Division
- Wang Zuozai, Chief, Plant Protection Division
- Chen Zongmao (Chen Tzung-mao), Associate Research Fellow, Plant Protection Division (Residue Chemist)
- Hong Beibian, Specialist in Plant Protection (Biological Control)
- Ying Kuanshan, Specialist in Plant Protection (Biological Control)
- Zhao Qumin, Specialist in Plant Protection
- Chan Xiefen, Chemist (Sex attractant of tea leafroller)
- Yu Yumin, Leader, Institute Administrative Office

1930 Seminars by Mr. Coulson and Drs. Cook, King, Klassen, Hagen and Yendol

Thursday, July 26, 1979. Hangzhou, Zhejiang Province

0800 "Technical Session" at Shileng Hotel, Hangzhou. Organizations represented at this session included the following (an unfortunately incomplete list of only those persons not met at previous visits to these organizations is also given here):
- Zhejiang Academy of Agricultural Sciences
- Zhejiang Agricultural University, Plant Protection Department
- Tea Research Institute, CAAS
- Zhejiang Bureau of Agriculture, Plant Protection Forecasting Station, Hangzhou

Zhang Congwang (Chang Ts'ung-wang)

1815 Departed Hangzhou by air for Guangzhou (Canton)

2045 Arrived Gangzhou. Met at airport by following persons, who were to be our escorts in the area:
- Wu Shangzhong, Plant Pathologist, Deputy Director, Guangdong Plant Protection Institute, Guangdong Academy of Agricultural Sciences
- Liu Zhicheng (Liu Chih-cheng, Liu Chih-ch'eng, Liu Chi Cheng), Entomologist of the Institute
- Lao Yanyung, Entomologist of the Institute
- Jiao Chuyao, Staff Member of Institute's Office of Foreign Affairs

Friday, July 27, 1979. Guangzhou (Canton), Guangdong Province

0800 Visit to the Biology Department of Zhongshan (Sun Yat Sen) University. The following persons were met during the visit:
- Pu Zhelong (Pu Chih-lung, P'u Che-lung), Professor, Head, Department of Biology
- Li Cuiying, Professor of Entomology
- Liu Fushen, Lecturer, Insect Ecology
- Zhou Changqin, Teacher, Insect Ecology
- Qian Manyun, Foreign Affairs Section of University
- Hua Lizhong(?) (Hua Lichung), Insect Taxonomist (Cerambycidae)

1430 Visit (Dr. Cook only) with Plant Pathologists of the Guangdong Academy of Agricultural Sciences (GAAS) at Dong Fang Hotel. The two pathologists present at the discussions were:
- Wu Shangzhong, Deputy Director, Plant Protection Institute, GAAS (see notes for July 26)
- Chou Lianggao, Plant Pathologist of the Institute

1430 Visit to the Guangdong Institute of Entomology, CAS. The following persons were met during the visit:
- Li Liying, Institute Deputy Director
- Peng Tongxu (Peng Tong-hsu), Deputy Chief, Insect Natural Enemies Research Division, or Biological Control Division
- Liu Nanxin, Deputy Chief, Insect Ecology Division
- Lin Ping, Chief, Insect Taxonomy Division
- Dai Zilong, Deputy Chief, Termite Division
- Xie Zhongnen, Leader, Insect Physiology Group
- Zhang Zhiqing, Deputy Chief, Division of Information (Library)
- Huang Mingdu (Huang Ming-dau), Assistant Research Fellow (research on integrated control of citrus pests)
- Wu Weinan, Assistant Research Fellow (research on predatory mites)
- Liu Wenfei and Li Kaihuang, Insect Natural Enemies Research Division (research on artificial diets for *Trichogramma*; biological control of *Eublemma amabilis*)

1930 Welcoming Banquet in Guangzhou. Host: Wu Duanjiang (Wu Duong-jiang), President, Guangdong Academy of Agricultural Sciences

Saturday, July 28, 1979. Guangzhou, Guangdong Province

0800 Visit to the Plant Protection Department of South China Agricultural College. The following persons were met during the visit:
- Li Peiwen, Vice President of the College
- Pang Xiongfei, Professor, Department Deputy Director
- Liu Xiuchun, Professor of Entomology
- Chen Shoujian, Associate Professor of Entomology
- Zhang Weichu, Associate Professor of Entomology
- Lin Kongxiong, Associate Professor of Plant Pathology
- Lu Jixiang, Deputy Chief, Administrative Office of the College

Saturday, July 28, 1979 (cont.)

1430 Visit to the Plant Protection Institute of the Guangdong Academy of Agricultural Sciences. The following persons were met during the visit:
- Wu Shangzhong, Institute Deputy Director (see July 26)
- Chou Langkou, Associate Research Fellow, Plant Pathologist
- Chan Weiyong, Assistant Researcher, Secretary of the Institute, and in charge of the insectary
- Liu Chiuzhing [sic] or Li Youchao [sic]5/, Assistant Researcher, Plant Pathologist
- Liu Zhicheng and Lau Yanyung, Entomologists (see July 26)

Sunday, July 29, 1979. Huiyang Region and Guangzhou, Guangdong Province

0800 Informal discussion with Mr. Yan Yuhua, the delegation's escort, concerning Beijing Agricultural University.

0830 Visit to Shilong Biological Control Experiment Station, Yunde County, Huiyang Region, where lunch was hosted by Wu Shidai, Director of the Station. Persons met during the discussions included:
- Tan Yumin, Deputy Chairman, Shilong People's Commune
- Wu Shidai, Experiment Station Director
- Liu Zhicheng, Entomologist, Guangdong Plant Protection Institute, and others met earlier

1500 "Technical Session" at Dong Fang (T'ung Fang) Hotel, Guangzhou. Discussions with many of the scientists from the locations visited by the U.S. delegation in the Guangzhou area.

Monday, July 30, 1979. Guangdong Province and Hong Kong

0830 Departed Guangzhou by train.

1230 Arrived Kowloon, Hong Kong.

Tuesday, July 31, 1979. Hong Kong. Discussion of potential future cooperative projects in biological control between the People's Republic of China and the United States, by U.S. delegation members.

Wednesday, August 1, 1979. Hong Kong and San Francisco

1530 Departed Hong Kong, later crossing International Date Line.

1200 Arrived San Francisco, where U.S. delegation members separated for separate routes home.

5/ The name of this researcher was unfortunately garbled in notes taken by the U.S. delegation.

Names 1/ — Page (p.) or Appendix (Ap.) No.

ARTHROPODS (insects, mites, and spiders) 2/
(including pest and beneficial species)

1/Refer to page references for both common and scientific names, and synonyms, if applicable, for complete reference to mention of organism.
2/Synonymic scientific names are indicated in parentheses and are cross-referenced to names currently used by U.S. taxonomists.

ARTHROPOD PATHOGENS
(microbial pathogens, entomopathogens, entomogenous microorganisms, and others)

NEMATODES
(including pest and beneficial species)

CROP[3] AND OTHER PLANTS

3/See also "Insects of," and "Pathogens and Diseases of" in Indices to Arthropods and Plant Pathogens, repectively.

PLANT PATHOGENS, DISEASES, [4]/ AND THEIR NATURAL ENEMIES

[4]/Causative agents, pathogens, are cross-referenced in parentheses; see both entries for complete reference to disease/pathogen.

MISCELLANEOUS MICROORGANISMS

VERTEBRATES

NOTES ON BIOLOGICAL CONTROL OF STEM BORERS IN CORN, SUGARCANE, AND RICE IN THE PEOPLE'S REPUBLIC OF CHINA

by

Alton N. Sparks, USDA
J. Roger Ables, USDA
Richard L. Jones, University of Minnesota

CONTENTS

APPENDIX

INTRODUCTION

The study team on biological control of stem borers in corn, sugarcane, and rice, consisted of Alton N. Sparks, U.S. Department of Agriculture; J. Roger Abeles, U.S. Department of Agriculture; and Richard L. Jones, University of Minnesota, arrived at Guangzhou on July 1, 1980, and left Beijing on August 4, 1980. They visited numerous universities, institutes, communes, and sites of agricultural and historical interest during this period of time. Zhou Durong, Chinese Academy of Agricultural Sciences, was their escort and interpreter.

These notes on their visit offer further information on the status of biological control of pests in the People's Republic of China.

The notes have omitted the seminars conducted by the team members and the hospitality activities provided by the PRC hosts. Similarly, most of the field visits not directly related to biological control of pests have been excluded from this report.

GUANGZHOU, JULY 2

Zhongshan University

The study team visited Zhongshan University on July 2, 1980. The following are notes from the visit.

The Biology Department of Zhongshan University has studied the use of the yellow ant, *Oecophylla smaragdina* Fab., for control of the citrus stink bug, *Rhynchocoris humeralis* (Thornberg), as well as other stink bugs and a few lepidopterous pests. The ant does not overinwter well in cooler climates. It tends to protect the mealy bug, but it does not bother lady beetles.

Current research areas on microbial control are: (1) The use of a nuclear polyhedrosis (NPV), produced on the cotton leafworm, *Prodenia litura* F., against several vegetable pests. Diseased larvae are crushed, centrifuged, dried, and packaged in vials for use at a rate of 10 larval equivalents per mu. The dried material is put out in a water emulsion. (2) The use of a NPV-CPV mixture against the pine caterpillar, *Dendrolimus punctata* Walker collections from sprayed fields revealed only CPV-infected larvae. (3) The development of a granulosis virus (GV) for the cabbageworm, *Pieris rapae* L., and one of the rice leafrollers, species not mentioned. (4) Research on a rickettsial disease of *Trichogramma* spp. The disease is nutrition linked, as the provision of fresh versus old eggs relieves the symptoms of vestigial wings and an early death (2 to 3 days).

No experiment has been conducted on the effects of NPV on virus in the field and there are no studies on virus longevity in the field.

The team saw a few slides of malpighian tubule structure of the eri silkworm, *Philosamia cynthia ricini* Donovan which has several distinct cell types, some with long and some with short microvilli. The Biology Department has not done any research on cell function.

Studies of the following subjects are conducted in the department: (1) Biology and development of the cockroach, Opisthopatia orientalis. This roach is reputed to have healing powers for broken bones and rheumatism. The roach is dried, pulverized, mixed with water, and drunk. A rearing chamber (about 6 ft^3) is used to rear the insects at various temperatures. All work is done under a constant scotophase. An optimal rearing temperature is 25° to 28° C, with a life cycle of 5 to 6 weeks. The entire holding room is cooled with a central unit to 15° C and the rearing chambers are separately heated to the appropriate test temperature. (2) Rearing -- Biology of Anastatus sp. (Eupelmidae). This parasite is released to control the lichee stink bug, Tessaratoma papillosa (Drury). It is reared on the egg of the banana skipper, Erisonota thorax L. The use of a large host egg increases the male-to-female ratio of offspring up to 10:1 above that of a small host egg (1:1). Also, the use of a fresh egg versus an old egg increases this ratio. The critical stage of the host egg here is embryo inversion.

The insect collection of the department contains 205,000 specimens. The department has a Hitachi HU-12A electron microscope with a scanning accessory, capable of 500,000X, and an LKB 8800 sectioning microtome, capable of 50 A sections, although 700 A was reported to be ideal. They also had a good ultracentrifuge.

The chemistry department of the university has two research areas related to insects: (1) Rice stem borer, Chilo supersalis pheromone. The female attracts the male and the optimum activity is from 1-3 a.m. Research on this pheromone has ceased. (2) Rice gall midge, Pachydiplosis oryzae Wood-Mason, pheromone. The department has isolated a chemical (1 ug per 10,000 females) which the staff think is an aldehyde. An equivalent of 15 females attracted 170 males. All of this isolation and identification work is actually done in Beijing.

The department has also synthesized 30 compounds with juvenile hormone (JH) activity. One of these chemicals is used to prolong the 5^{th} instar silkworm by 1 day. This increases silk production by 15 percent. A separate copound (II) is used in a 0.05 percent spray to give 70 percent control of the citrus red mite, Panonychus citri (McGregor).

SIHUI COUNTY, GUANGDONG PROVINCE, JULY 3

Dasha People's Commune

The study team visited the Dasha People's Commune, Sihui County, Guangdong Province, on July 3. The following are notes on that visit.

Commune statistics. The commune has 78,000 mu of total crop production, including 60,000 mu of rice, 6,000 mu of sugarcane, 4,000 mu of peanuts, and 5,000 mu of fish pools. The commune is organized into 18 brigades, 217 production teams, and 1 fish production brigade. The commune has 7,889 families and 55,000 residents, of which 32,000 are farmers.

Integrated Pest Management (IPM) of Rice Pests. The key pests are paddy borer, Scirpophaga incertulas (Walker); rice leafroller and rice leafhopper, Cnaphalocrosis medinais Guenée; brown planthopper, Nilaparvata lugens Stal; and oriental armyworm, Luecania separata Walker.

Before IPM insecticides were the major control strategy; commonly used compounds were BHC, dimethoate, imidan, derris, parathion, and malathion. In 1972, approximately 136,483 kg of chemicals were applied to rice at a cost of $1.56 per mu. After the implementation of IPM in 1973, insecticide use was reduced by around 50 percent in 1974, and to less than 20,000 kg per mu in 1976- 1979. IPM was applied to 24.2 mu (early crop) and 307 mu (late crop) in 1973 and increased to 1500 mu in 1974, and to 60,000 mu (entire rice crop) by 1975. Total populations of natural enemies have increased by 60 percent. Rice leafroller infestation decreased from an average of 10 percent of the crop (46.6 percent is severely infested fields) to 1.9 percent. Brown plant-hopper is now rarely a pest. Yields have increased and stabilized at 475 kg per mu per yr, whereas up to 5 million kg in losses had previously occurred in the 60,000 mu of rice.

Components of IPM. The commune's IPM program has the following components: (1) Habitat improvement via improved irrigation and drainage systems; (2) cultural control via (a) varietal selection and (b) plowing and flodding soon after harvest to reduce overwintering of stem borers in stubble; (3) rear and release ducks at the rate of 3 ducks per mu -- as many as 300,000 ducks may be used in the commune (110,000 in 1980); (4) rearing and release of Trichogramma dendrolimi Matsm. on 5,000 to 6,000 mu at the rate of 10,000 per mu twice during each leafroller generation; (5) scouting and selective applica- tion of insecticides. Most treatments are for thrips. Monitoring teams consist of 9 people from the commune, 37 from brigades, and 237 from production teams. (6) The commune has two 1.5-ton-capacity fermentation tanks for the production of Bacillus thuringiensis (B. t.).

The fish raised in the commune was the bigheaded fish, a grass feeder. Most of them are sold on the Hong Kong market. The production is 200 kg of fish per mu per yr. The fish are divided into three classes for production: (1) baby -- 0-20 days; (2) second stage -- up to 100 gr; and (3) 100 gr to market (1-1.5 kg). It takes 8 to 10 months to raise the fish to market size.

GUANGZHOU, JULY 4

The study team visited the Guangdong Institute of Entomology and the Guangdong Institute of Chemical Analysis and Identification at Guangzhou on July 4. The following notes are from those visits.

Guangdong Institute of Entomology

Biological control is the primary research thrust of this Institute. Its research activities include: (1) biology and in vitro rearing of Trichogramma, (2) effects of insecticides on natural enemies, and (3) taxonomy of natural enemies. Trichogramma is apparently most emphasized. Research on Trichogramma began in 1970. Eighteen species are recorded from China (see appendix). In Guangdong Province, T. dendrolimi Matsm., T. confusum Vigiani, and T. japonicum Ashmead are the three most common species. However, the local fauna and its

ecology are not yet well understood. Recently, T. pretiosum Riley was introduced from Texas, and Dr. J. M. Franz (West Germany) provided the Institute with T. evanescens Westwood and T. cacoaecae from Europe. Investigations on the biology, ecology, host range, and mass production of these three species have been initiated.

In 1975 work began on in vitro rearing of T. dendrolimi. A few adults were produced in vitro in 1976. To date, the best Chinese diet returns 25 percent adults per 100 parasite eggs laid. Briefly, artificial eggs are prepared as follows: silkworm pupae are placed in H_2O (60° C) to denature hemolymph proteins, collected hemolymph is placed in a vial and covered with a thin layer of vaseline-wax (MP 48° C) in 1:3 ratio, and the mixture is held at 55° to 60° C and the hemolymph is drawn through the overlying waxy layer via a 0.5- to 1-mm (ID) capillary tube and the droplets placed on glass slides. The ratio of vaseline to wax controls the thickness of the waxy layer and the capillary tube size controls egg size.

Guangdong Institute of Chemical Analysis and Identification

This Institute consists of four laboratories: organic chemistry, inorganic chemistry, radioisotope laboratory, and instrumentation. The organic chemistry laboratory reported Z-9-dodecenyl acetate as the sex pheromone of the sugarcane borer, species unspecified. Screening of synthetics revealed that Z-11-dodecenyl acetate was more active than the natural compound. It caught more than three virgin females. Z-7-dodecenyl acetate was also active. The laboratory had no information on mixtures of these isomers.

In 1977, the laboratory began work on the pheromone of the corn borer, Pyrausta (Ostrinia) fernicalus, with 30,000 field-collected insects. Conventional techniques led to the identification of E:Z-9-tetradecenyl acetate (53:47). This ratio was determined from females 24-48 hours old. In field studies, saturated tetradecenyl acetate is added at 1.8 fold to the Z:E mixture. Pheromone tests are conducted from 3:00 to 5:00 A.M., and 0.1 ug to 10 ug was reported as the optimum range of each.

This chemistry group also works on traditional Chinese drug identification and on insect hormones.

GUANGDONG PROVINCE, JULY 5

The study team visited the Biological Control Experiment Station (Guangdong Province) on July 5. The following are notes from that visit.

Shilong Biological Control Experiment Station

This station was begun in 1969. It now has 5 technicians and 25 workers (30 total) working on sugarcane IPM and Trichogramma rearing. It has 270,000 mu of sugarcane and several million lichee trees in a six-county area. IPM in the station has increased from 5,000 mu in 1970 to 30,000 mu in 1974. IPM and/or release of Trichogramma for control of the sugarcane stem borer (three species: yellow sugarcane borer, Chilotraea infuscatella Snellen; internodal borer, Chilo sacchariphagus indicus Kapua; and grey sugarcane borer, Argyroplace schistaceano Snellen) has increased from 13,000 mu in 1975 to 45,000 mu in 1978 and 55,000 mu in 1979-80.

Trichogramma Rearing and Release. Trichogramma dendrolimi (and probably two other species) is reared on castor silkworm and oak silkworm (see appendix). Before release and emergence, on the day of oviposition or the day after, parasitized Trichogramma eggs are placed in outdoor cages for acclimation to field conditions. Production is from 50 to 60 parasites per oak silkworm egg and 20-30 per castor silkworm egg. The handling of host eggs has been mechanized (see appendix). The facilities at Shilong allow for the production of up to 1 billion Trichogramma in 8 hours. This is enough to release on 300,000 mu of sugarcane.

On sugarcane, Trichogramma is released in seven to eight releases of 5,000-10,000 per release per mu at five points per mu. The initial release of Trichogramma is made at the first appearance of the pest, as judged by either moth appearance or egg samplings. For example, the appearance of one to two egg masses per m^2 is the threshold for initial release; 10 samples of 1 m^2 per field of about 300 mu is considered adequate sampling.

The cost of Trichogramma to the farmer is .1 yuan per 10,000 or about .7 yuan per mu per season. This is a reduction of 90 percent from the cost of chemical control of 7-10 yuan per mu per season. Each year, one or two farmers from each production team are trained in Trichogramma-release techniques. The parasite is distributed to release areas 3 days prior to the predicted hatch of pest eggs. The station also uses pupation curves and degree days to predict adult moth emergence.

Anastatus rearing and release. An Anastatus sp. is used to control the lichee stink bug. It is reared on the castor silkworm egg. Currently, sufficient parasites are reared for release on 6,000 trees, but the station has the capacity for rearing enough parasites for release on 200,000 trees. The parasites are released in three releases at a rate of 200, 400, and 200 adults per tree. The initial release is 3 days prior to stink bug oviposition. Stink bug oviposition dates are determined by the collection and dissection of the females.

The Anastatus are reared in 6x30x22-cm wooden-framed screen boxes (designed with small shelves to hold host eggs) in which 3000 castor silkworm eggs and 1200 parasites (800 females and 400 males) are introduced. The parasites are removed after 24 hours and the host eggs are placed in storage. A subsample of host eggs is held for observation of percentage parasitism and sex ratios. This information is used for field release of parasitized eggs. The life cycle of the parasite is 15 days.

Pesticide Use. Since IPM and parasite release began, the use of chemicals on sugarcane has been reduced by 70 to 90 percent. Rogor and Dipterex had been used in 10 applications at 0.25 kg per mu for borer control. Before IPM, borer damage to cane was 10 to 30 percent. In 1980, the damage was 5 percent. Use of pesticides on lichee trees were sprayed three to four times per year with 1.0-1.5 kg per mu (60-70 trees per mu).

IPM Components on Sugarcane. The IPM on sugarcane includes the following components: (1) Cultural methods which include (a) stubble removal from the field, and (b) rotation of crops; (2) resistant varieties; (3) Trichogramma release; (4) natural enemy protection - by pesticide reduction; and (5) insecticide use restricted to small areas and used only when necessary.

GUANGZHOU, JULY 7

The study team visited the Institute of Plant Protection of the Guangdong Academy of Agricultural Sciences on July 7. The following are notes on that visit.

Institute of Plant Protection, Guangdong Academy of Agricultural Sciences

This Institute has 97 workers (49 scientists). Research is in two principal areas: (1) rearing of beneficial insects, and (2) production of *Streptomyces jingaggensis* for control of rice sheath blight (*Rhizoctonia* sp.), rice bacterial blight, and the brown planthopper, *Nilaparuata lugens* Stal.

Production of Streptomyces. This fungus is fermented on a rice medium (one-half cooked plus 2 percent yeast powder). The medium is very moist but with no free water. The medium is inoculated with mycelia from a pure culture (maintained on PDA). The flask is incubated at 32° C for 15 to 20 days, after which the medium is removed and dried. At this point, there is mostly mycelia but some spore formation.

For use against the brown planthopper, the dried medium is diluted 1 per 15 with water and sprayed on the plant for 70 to 80 percent control. The hoppers cease feeding and die with a swollen body within 3 days. The residue is active for 5 days. This treatment is causing increased insecticide tolerance.

For use on rice sheath blight, a 40-ppm foliar spray persists for 20 days and gives over 80 percent control. The material is both prophylactic and therapeutic. It has been used on over 15 million mu.

When applied against one of the blights (which one is unclear), it is applied in the boot stage in two applications (0.14 per mu). No phytotoxicity has been observed.

The Institute also rears the castor silkworm on a castor leaf, soybean meal, and cassava meal diet supplied to the larvae daily. The exact composition of the diet is confidential.

The *Lixophaga*, brought to the People's Republic of China by the team had emerged (90 percent) and were in good shape.

CHANGSA, JULY 10

Institute of Plant Protection, Hunan Academy of Agricultural Sciences

The study team visited the Institute of Plant Protection of the Hunan Academy of Agricultural Sciences on July 10. They reported that the Institute worked on crop diseases and insect pests and had 33 research workers within four laboratories (crop diseases, insect pests, biological control, and chemicals). Changsa produces two crops of rice annually, along with a winter crop of wheat or green manure. The alternate flooding and draining of the rice paddy was beneficial to spider populations. The procedure for both crops is as follows:

Early crop

1. 2-3 cm of water is held on rice for 30 days after transplanting to allow good root development.

2. Water is drained and the rice is left under the sun for 6 to 8 days.

3. Then the paddy is irrigated with 2-3 cm water which is allowed to dry naturally. This is repeated several times, depending upon the weather (dry season: six to seven times; wet season: two to three times).

Late crop

1. Transplanted rice is held under deep water (5-6 cm) because of summer heat.

2. After 4 to 6 days, the water level is reduced to 2-3 cm.

3. When rice reaches the tillering stage, the field is drained for 2-3 days.

4. Alternate flooding and draining until harvest.

HUNAN PROVINCE, JULY 11

Xingying County Experimental Center

The study team visited the Xingying County Experimental Center on July 11, 1980. The Center had 570,000 mu of rice, of which 275,000 were under biological control. The team visited several cotton and rice fields and found virtually no insects present. They collected about 12 to 15 clusters of *Apanteles ruficrus* (Haliday) cocoons in rice, but about 80 percent were hyperparasitized by pteromalids.

CHANGSA, JULY 12-13

On July 12 and 13 the team revisited the Hunan Plant Protection Institute. The following notes and observations are from that visit.

Hunan Plant Protection Institute

Research on spider biology and ecology. The use of spiders for pest control dates back 2,000 years. In the People's Republic of China, 18 families and 128 species of spiders are known; in Hunan, there are 16 families and 113 species. Spiders may represent 70 to 90 percent of all predators in rice fields. Thirty to 60 thousand spiders per mu are common in untreated fields, and two to six generations may occur each year. An interesting conservation procedure is the placement of shelters (bundles of straw) in the fields. Spiders crawl onto the straw during irrigation. In former years, these shelters with spiders were transferred to other fields. In 1979, 50,000 mu (estimated 200,000 mu in 1980) in Xiangying County used the conservation of spiders approach. It was reported that insecticide use in this area has declined by 50 to 60 percent.

Research on Trichogramma. Five species of *Trichogramma* are found in Hunan. The species are determined by placing laboratory-reared host eggs (on cards) in the field every 5 days between February and November. Parasites first appear in February or early March. Natural populations may be quite high. For example, during third generation rice stem borer in late August 1964, 92.3 percent of the eggs were parasitized at a density of 11,800 masses per mu. Furthermore, dead-hearts were only 1.8 percent. During 1954-56, two species (*T. japonicum* and *T. chilonis*) were reared on *Chilotraea cephalonica* and/or *Sitotroga* for release against stem borers in rice and Asiatic corn borers. Release at 3,000 to 5,000 parasites per mu of rice produced 38.6 percent parasitism of borer eggs versus 0.9 percent in the control.

More recently, work has been done in Jiangxi and Yunnan Provinces. In rice (Yunnan Province), 69 percent parasitism of borer eggs was achieved. During 1956-58, *T. evanescens* was tested in Hunan for control of Asian corn borer on corn and jute. On spring corn, yields in release plots were 5.9 to 8.7 percent greater than in the control. Releases produced negligible effects on summer corn due to high natural rates of parasitism. On jute in Xiangying County, the percentage of damaged plants in release fields on July 18, 1958, was 0.3 versus 4.8 percent in the control.

During 1972 to 1974 in Juiyang, Linwu, Chenxian, and Jiangyou Counties, another egg parasite, *Tetrastichus schoenobii*, was reared on yellow rice borer and white sugarcane borer (*Scirpophaga nivella* F.) for release on 110.4 mu at the rate of 5,300 parasites per mu. Egg parasitism in release fields was 62.9 to 94.7 percent greater than in control plots. However, the host species cannot be reared on a large scale.

In 1975, in Qiyang County, a rice IPM pilot program was established. By 1979, the early season program involved 540,000 mu and late season 520,000 mu (about 94 percent of total area). As part of this program, *Trichogramma dendrolimi* and *T. chilonis* were reared on the tusser silkworm (*Antheraea pernyi* Guérin-Meneville); 2.3 billion parasites were reared and parasites were released on 36,000 mu. The second generation rice leafroller egg parasitism averaged 68.7 percent (93.7 percent maximum).

Overall, between 1973 and 1980, the Institute reared 12.5 billion parasites for release on 400,000 mu (about 31,000 per mu cumulative).

Also, in the 1979 Qiyang Country IPM program, *B. t.* was used on 120,000 mu at the rate of 1.25 kg per mu (6 billion spores per gm). A total of 150,000 kg of *B. t.* was utilized. The rice leaf roller control was 70 to 80 percent, while the yellow rice borer control was 82.2 percent.

Further information provided indicated that four strains of *B. t.* have been used. Origin of the strains was (1) pine caterpillar, (2) pink bollworm *Bacillus* 7216, (3) borer *Bacillus*, and (4) *Bacillus* #3 obtained from USSR in 1956. These strains were reported to give 70 to 80 percent control of yellow rice borer and over 90 percent control of pine caterpillar, bollworm, pink bollworm, rice skipper, rice leafroller, and Asian corn borers.

In 1978 Beauvaria bassiana was reportedly used on 2 million mu to control the green rice leafhopper. One kg per mu (10 billion spores per gm) gave 90 percent control. Emphasis on the requirement of above 50 percent RH for effectiveness was stressed; therefore, Beauvaria use is restricted to April and May.

Ducks were utilized as yet another IPM tool. In 1979, 800,000 ducks were used on a total of 160,000 mu. Planthoppers and leafhoppers were reduced from 85.6 percent to 47.6 percent. Examples of reduced pesticide usage throughout this program include:

1971	3.30 million kg pesticide used
1978	1.83 million kg pesticide used
1979	1.48 million kg pesticide used

ZHEJIANG PROVINCE, JULY 15

Zhejiang Academy of Agricultural Science

The study team visited the Zhejiang Academy of Agricultural Science on July 15. The following notes are from their visits to the Institutes of Microbiology, Plant Protection, and Horticulture.

The Institute of Microbiology consists of three laboratories: Agricultural Antibiotics, Nitrogen Fixation, and Biogas Production. The Institute employees 73 people, including 17 senior scientists.

The Institute has begun research on aphicidin, a new insecticide isolated from Streptomyces griseolus var. Hangzhouensis (similar to S. griseolus by Waksman in 1923 in in the United States). The material has been identified but not yet synthesized. A 1 per 100 dilution of the fermentation medium gives better control than phosphomidan or systox on aphids. The chemical is reputed to be nontoxic to several species: lady beetles, braconids, spiders, lace wings, and syrphids. High concentrations are toxic to lepidopteran larvae, but it is safe to mammals with an LD_{50} (oral) to white rot of 60 mg per kg. It causes nervous tremors in the aphid and is highly specific to certain enzymes in the respiratory chain. The procedure for fermentation is included in the appendix. The microbiology laboratories were the cleanest and the best equipped in the People's Republic of China.

The Institutes of Plant Protection and Horticulture have researchers in the following areas: (1) Life cycle of Heliothis armigera (laboratory studies), (2) factors affecting outbreaks of H. armigera, (3) phenology of pink bollworm, and (4) artificial rearing of Chrysopa sp.

The work on caged releases of sterilized diamond-back moths, Plutella xylostella, a major vegetable pest in South China, look promising and the data are included in the appendix.

ZHEJIANG PROVINCE, July 16

The study team visited the Zhejiang University of Agriculture on July 16. The following are notes from its meetings in the Department of Plant Protection with PRC scientists.

Zhejiang University of Agriculture

The Zhejiang University of Agriculture is 79 years old and consists of nine departments: agronomy, horticulture, sericulture, tea culture, animal husbandry, veterinary medicine, agricultural machinery, agricultural economics, and plant protection. The Department of Plant Protection has 180 students, including 10 postgraduates. The three teaching and research groups are: entomology, plant pathology, and chemical protection. The Department has 62 staff members: 5 associate professors, 27 lecturers, 11 assistants, 8 technicians, and 6 officers. One thousand students have been trained since 1949.

Overview of Entomology Research Areas

1. Biocontrol. This work was started in 1930. The department has a collection of 60,000 Hymenoptera specimens.

    a. Survey of insect resources
    b. Egg parasites of rice borers, especially *Tetrastichus* sp.
    c. Parasites of the pink bollworm.

2. IPM of wheat and rice pests
3. Pests of mulberry
4. Pheromone of wild silkworm, *Bombyx mandarina*
5. Biocontrol of *Pieris rapae* - granulosis virus
6. Chinese walnut - gall insects
7. Work on ants, some taxonomy
8. Work on stored-product insects
9. Work on pests of jute
10. Pesticide residues.

The department has studied integrated control of rice pests, collected data on the abundance and distribution of the parasites of five key rice stem borers present in the People's Republic of China. This included all groups of parasites along with ratings of their effectiveness on each of the borers.

From observations of the data, the following species appeared to be promising in the United States: *Gambrus wadai* Uchida (Ichneumonidae), *Isotima javensis* Rehwer, *Bracon onuki* Watanabe (15-day life cycle), *Habrobracon* sp., and *Tetrastichus schoenobii*.

The following parasites are the easiest to rear: *Amavramorpha accepti schoenobii* (Vierecki), *Isotima javensis*, and *Centeterus altemealoratus* Cushman (introduced into Hawaii in the 1930's).

The major pests of rice are: (1) brown planthopper, (2) leafroller, (3) stem borers, (4) sheath blight, (b) bacterial blight, (6) leafhoppers, and (7) thrips; the first three are most important. IPM was initiated in 1975 and by 1977 included the entire commune of 500 hectares. The rice yields are as follows: 1976, 1385 jin per mu; 1977, 1464 jin per mu; 1978, 1849 jin per mu; and 1979, 2071 jin per mu (all figures are based on two crops per year). During this period, the cost of pesticide was reduced from 4.5 yuan per mu (seven to nine applications) to 2.1 yuan per mu (two to four applications). Yield losses due to pests have decreased from 10 percent to less than 1 percent. Most of the yield increases were due to variety changes and improved cultural practices.

The components of IPM are: (1) Use of tolerant varieties. The department has a rather complex scheme of plantings of certain ratios of early and late varieties for both the first and second crops of rice. Both crops utilize small areas of trap crops of a different variety. (2) Use of manure as a basal fertilizer. Chemical fertilizer is used as a side dressing. (3) Better drainage and irrigation. (4) Limited pesticide use. They use Tamaron, Galecron, Kitazin, Dipterex, Rogor, Dichlorovos, NHC, and Parathion. Furadan is put in with the seed.

The pesticides are applied locally to infested paddies. The farmers have also reduced the volumes and frequency of pesticide use. IPM is reportedly not always effective because of the natural enemy fluctuation. Pesticide residues in rice were 105 ppm BHC on dehusked rice and 0.17 to 0.60 ppm arsenate on rice (including husk).

The department now works on a spider, *Frigonidium granimicolum*, and a staphylinid, *Paederus fuscipes*.

SANGYU COUNTY, July 18

The study team visited the Guzhu Brigade, Shaojin Commune, on July 18. The following are notes from that visit.

Guzhu Brigade, Shaojin Commune

The Guzhu Brigade has been successful in controlling pink bollworm via pheromone in traps. The pheromone traps consist of a 6-inch-diameter bowl, half filled with water, supported by three bamboo poles. The water contains 0.5 percent detergent on which the pheromone, in a plastic container, floats. A total of 2047 traps was placed in 534 mu of cotton; 16,218 lures attracted 673,375 pink bollworm males in 1979.

The overwintering generation of pink bollworm comes from cottonseed stored in the village. An attempt was made to capture these overwintering males via placing 100 to 300 traps at 35-m intervals between the overwintering site and the cotton field.

The bridgade reports a 31 percent decrease in infested flowers compared to a neighboring brigade, but they do not know where mating of the overwintering generation takes place, or the nocturnal behavior of the pink bollworm.

Fish production in the commune is accomplished by confining carp and related species in net boxes (1 per 10 mu) in a larger, but not deep, body of water (about 1 to 2 meters). The fish are fed grasses and barley. This commune harvests 25,000 kg of fish per year from 28 net boxes.

JILIN PROVINCE, July 23

On July 23, the study team was briefed on the insect control and IPM programs of Huaiteh County, Jilin Province. The following notes are from the briefings.

Asian Corn Borer Phenology. *Ostrinia* population occurrences in Jilin Province are apparently similar to those in the United States. Their generation times and diapause development vary with temperature.

Trichogramma. Use of *Trichogramma* is mainly in the eastern portion of the province: 15,000 to 20,000 parasitized eggs per mu are placed in the field (actually about 8,000 per mu since the degree of parasitism varies). *Trichogramma dendrolimi* are released onto silk-stage corn; 60 to 70 percent egg parasitism is reported. Three species of *Trichogramma* commonly occur in Jilin. *T. dendrolimi* comprises 95 percent of all species collected on corn in eastern Jilin, while *T. nubilalae* (= *ostriniae* ?) is predominant in the central portion of Jilin. The third common species is *T. confusum*.

As recently as 1977, 2.2 million mu had received releases of *Trichogramma*. Current figures are much lower (about 1 million mu) because of lower borer populations, primarily due to the rapid spread of a "European stink disease" among parasite cultures. In 1976, the Liuhe County rearing facility nearly lost its culture due to this disease.

Beauvaria. In the western region, a native strain of *B. bassiana* is used against corn borers. Fungal spores are mixed with sand as a carrier. Five billion spores per gram of product occur and 1 kg of product per mu are mixed with 20 times the amount of sand (5 trillion spores per mu). Better than 90 percent control is sometimes achieved.

BEIJING, JULY 27

The study team visited the Miyun County Plant Protection Station on July 27. The following are notes from that visit.

Miyun County Plant Protection Station

Although *Trichogramma* use was initiated at Miyun County in 1965, the station was not established until 1976. It has a work force of more than 40 workers.

The Plant Protection Station has responsibility for control of insects on 400,000 mu of crops, 200,000 mu of fruit trees, and 150,000 mu of forest. The principal field crops are corn, wheat, and peanuts. The armyworm and Asian corn borer are the primary pests of corn. In 1977, 30,000 mu of corn were treated with *T. dendrolimi* for corn borer control, and then in 1978-80, 300,000 mu of corn was treated with *T. dendrolimi*, with limited use of

T. ostriniae. The preferred Trichogramma sp. is Ostriniae because it is somewhat host specific and believed to be more effective, and it comprises 90 to 95 percent natural population of Trichogramma from field-collected parasitized egg masses. However, the laboratory host species, rice grain moth, for rearing Ostriniae is currently very difficult to produce reliably on a large scale.

Estimated production potential of T. dendrolimi on oak silk moth eggs is 30 billion per year; however, current production is about 10 billion per year. Estimated cost to the farmer is 7 fen for 10,000 Trichogramma. This includes the cost of Trichogramma and release cages at 3.5 fen each, using only one release site per mu. On corn, for Asian borer control, two or three releases of 10,000 Trichogramma per mu per release are made. In forests, for control of pine caterpillar, four releases totaling 40,000 to 50,000 Trichogramma are prescribed.

Oriental fruit moth and leafroller on fruit trees are controlled by 11 releases of 10,000 T. dendrolimi per release per mu. No insecticide is needed. The PRC scientists state that Trichogramma is good for Asian corn borer control, but is most promising in fruit orchards. Their reasoning is that because Trichogramma is so cheap and the crop value so high, farmers will release twice as much or more Trichogramma than the prescribed rate. In addition, lack of insecticide control preserves natural enemies, predaceous spider mites in particular.

Armyworm control is reported to be easy by use of ULV Dipterex (25 percent in oil) applied at 40 to 50 gm per mu. The team inspected a heavily infested field of Asian corn borers in the area where T. dendrolimi had been released. They reported that egg masses were no more than three per 100 plants and probably about one per 100 plants, with one to three larvae found in the tassel of infected plants.

The team returned to the station at 9:30 P.M. for field work. They put out Heliothis zea, H. virescens, and S. frugiperda pheromones. About 1 mg (1 ul) of the H. zea and H. virescens pheromones and the same quantity of Z-11-dodecenyl acetate and Z-11-tetradecenyl acetate were placed on each of four cigarette filter-sized rolls of toilet tissue. The "wicks" were placed about 1 cm above the water in a wash basin of about 50 cm in diameter, and the wash basin was placed 1 meter above the ground at the western edge of a peanut field. To the west of the traps was a silking corn field. There was a patch of millet adjacent to the peanut field to the north. The wind was from the northeast. Also, a wick of corn earworm pheromone and a wick of Z-11-dodecenyl acetate were placed about 1 to 2 meters away from a TV camera located in the peanut field. The distance between the traps was 10 meters. A wire cage (2x30x40 cm) containing eight virgin female Asian corn borers was placed about 1-1 per 2 meters above the ground in the peanut field.

Beginning at about 10:00 P.M., activity in the field was monitored with the TV camera. This camera could be remotely controlled from the laboratory. Focus, zoom, f-stop, and vertical and horizontal directions were controlled from a switchboard. The camera had a f 1.4 lens with a 15-90-mm zoom. The night was reasonably bright and the light application of the unit made observation of moth activity very easy. Conditions were quite windy.

Six or seven males approached the *H. zea* wick over a period of about 1 hour. None of these males attempted to land on the wick. The wind was causing the wick to move around considerably and the constant visitation of technicians to the study area during the observation period had hindered the study.

The team also observed the female corn borers calling, and two to three borers approached the cage containing the females.

There was no catch of males in the water traps and no activity was observed around the Z-11-dodecenyl acetate wick. The field work was adjourned by midnight.

BEIJING, JULY 29

The study team visited the Chinese Academy of Agricultural Sciences on July 29. The following are their notes on the visits to the Biocontrol Laboratory.

Biological Control Laboratory, Chinese Academy of Agricultural Sciences (CAAS)

In the Biocontrol Laboratory, the rice moth and several species of *Chrysopa* (*C. septempunctata*, *C. sinica*, *C. formosa*, and *C. carnae*) are reared. The *Chrysopa* are reared by methods very similar to those developed by R. K. Morrison (USDA, College Station, Texas), except that each developing larva is not isolated. Thus, some cannibalism occurs. Overall survival from egg to adult is 60, 70, and 80 percent for *C. sinica*, *C. septempunctata*, and *C. formosa*, respectively. Larvae are fed some aphids but reared mainly on eggs of the rice grain moth (RGM). Approximately 36,000 RGM eggs are applied in a uniform layer to 3x5-inch index cards with honey. The cards are placed in rearing boxes with larvae. One card yields about 1,000 larvae. Adults are fed on a diet of honey and brewer's yeast powder applied to a plastic "feeding bridge." Adult food is changed about every 3 days but can remain as long as 5 days without fermentation. Adults are placed in oviposition cages at a ratio of 75 females to 25 males. In a 24-hour period, each cage of 100 adults yields about 1,000 eggs.

A machine has been developed for the production of artificial eggs. Basically, water under pressure is shot through a bath of melted wax (MP 52° C) resulting in a spray of wax droplets which are collected onto a piece of paper. A "No. 6" nozzle (appeared to be a modified hypodermic needle) and a pressure of around 2 kg per cm^2 is used. Droplet size appears to be quite variable.

The Laboratory staff reviewed the use of *Trichogramma* for control of *H. armigera* on cotton in six provinces plus the Beijing area during 1976. The parasites were mostly used in Shanxi Province where 189,255 mu (12,000 acres) were treated. A special strain of *T. dendrolimi* was used. All together, more than 202,000 mu were treated with two to three releases of 30,000 parasites per mu per release. An average of 70 percent parasitism of eggs was reported. In addition to *T. dendrolimi*, *T. confusum*, and *T. euproctidis* were used. Cost was estimated at 7 fen per 10,000 parasites.

The laboratory currently has a research program on the use of Encarsia formosa Gahan, for control of whitefly on greenhouse-grown tomatoes and cucumbers. In 1980, parasites were released at the rate of 100 parasites per 130 whitefly scales. The collected leaves were shown to be about 98 percent parasitized.

Aphids and bollworms were two major cotton insect problems. Aphids became a problem after systemic insecticide use was initiated in 1953. Azodrin or Rogor (Cygon) is used against aphids and pyrethroids are used against aphids and bollworms (0.5 gm per mu for aphids and 1 gm per mu for bollworms).

The bollworm completes four generations per year. The first generation is in wheat fields, the second attacks small cotton squares, and the fourth generation generally is parasitized by Campoletis cloridiae (?) at about the 30 percent level and occasionally reaches 55 percent. Low egg hatch is reported for the fourth generation, due to high temperatures (34-35° C).

Chrysopa sinica Tjeder has been reared artificially. Adults and larvae have been reared on separate diets for 24 generations. About 70 percent cocoons are returned per 100 eggs infested. Females of the first two generations oviposited 1,000 to 1,500 eggs per female, but oviposition decreased after three generations. Insect stages were reported to be quite normal.

In 1963 in the western part of China, in one 10-day period, 500,000 adult armyworms (lured to wheat straw attached to trees and sprayed with sugar and vinegar) were marked with dye. About 1,000 sampling stations captured five marked moths from 600 to 1,400 km from the release site. No captures wer made less than 600 km distance. Migration studies have been initiated in Jiling Province since 1978.

The sterile insect technique, as applicable to the Asian corn borer, holds promise and the laboratory has initiated a pilot test on a small island.

BEIJING, JULY 30

The study team visited the Institute of Plant Protection, Chinese Academy of Agricultural Sciences, and the Institute of Zoology, Chinese Academy of Science, on July 30. The following notes are from those visits.

Institute of Plant Protection, Chinese Academy of Agricultural Sciences (CAAS)

The phenology of Asian corn borer biology is very similar to the European corn borer as found in Central Iowa. Populations are reported to be low, a cumulative density of 20 to 30 masses per 100 plants. An estimate of 2 to 3 percent loss is reported at this infestation level. The first generation is easy to control with chemicals, whereas second generation control is difficult.

T. ostrinae is again reported to be the dominant species of five attacking the egg masses. (It represents 95 percent of the Trichogramma population emerging from field-collected eggs.) The five species listed were: T. ostrinae, T. japonica, T. confusum, T. evanescens, and T. closterae.

The *Trichogramma* release strategy consists of two to three releases (depending on success or corn borer populations), usually made either at a rate of 3,000-5,000-7,000 per mu or 3,000-4,000 per mu. The first release is made prior to or at the first indication of egg masses (0.2 to 0.3 per 100 plants), the second release 4 days later (2 to 3 masses per 100 plants), and a third release 4 days later at a pest density of 5 to 6 masses per 100 plants.

Natural parasitism rates of egg masses by *Trichogramma* sp. are low initially. By July 25, the rates approach 20 to 30 percent, and accumulate to 80 percent or higher thereafter.

The pine caterpillar, *Dendrolimus* sp., has around 200 species of natural enemies, 30 percent of which are parasitic *Hymenoptera*. Parasitism rates are observed to be higher in mixed hardwood per pine forests than in the coniferous forests. First generation parasitism is usually 0.5 to 0.8 percent. The pine caterpillar undergoes a 5- to 7-year cycle. In the north, *Trichogramma* establishment is difficult because the caterpillar overwinters as a larva.

Institute of Zoology, Chinese Academy of Science (CAS)

The Institute of Zoology has 10 laboratories, 5 of which concern entomology. The Institute employs 360 workers, 60 associate professors, and 130 lecturers. The five departments related to entomology are: [1] Taxonomy - survey and identification of natural enemies: (a) This section is large and employs 60 people; (b) the museum contains 2 million specimens with about 1,000 holotypes; (c) the museum has a good collection of stored-product insects, the most important ones in China being: *Sitophilus oryzae*, *Sitotroga cerealla*, *Rhizophilus* - sawtoothed grain beetle, *Cryptolestes minutus*, and *Cryptolestes ferrugineus*; (d) the museum has conducted research on noctuid; (e) a good collection of Ichneumonids and Braconids (three cases each); and (f) a good collection of Tachinidae (six cases); [2] Ecology - fluctuation of natural enemies in the field; [3] Physiology: (a) Artificial diet for coccinellids; (b) *Trichogramma* rearing (*in vitro*); (c) *Bombyx mori* brain hormone; (d) *Bacillus thuringiensis* mode of action; (e) Insect virus survey - target: bollworm and armyworm, (f) milky disease isolated from a cutworm - now checking the number of hosts, effective on grubs; (g) fat body lipoproteins and hormone control; and (h) general insect biochemistry; [4] Pheromones: (a) *Dendrolimus* sp., and (b) Oriental fruit moth; and [5] Toxicology: (a) Structure - activity work, DDT analysis; (b) resistance mechanisms; and (c) their *Musca domestica* culture is over 20 years old.

APPENDIX 1

LIST OF *TRICHOGRAMMA* SPECIES KNOWN TO OCCUR IN THE PEOPLE'S REPUBLIC OF CHINA

Trichogramma *dendrolimi* Matsumura 1926 +
" *confusum* Viggiani 1926 +
" *evanescens* Westwood 1833 *
" *japonicum* Ashmead 1904 +
" *embryophagum* Hartig 1833
" *ostriniae* Pang and Chen 1974 (Nagarkatti considers this a synonym of *T. chilotraea*)
" *chilonis* Ishii 1941 #
" *chlosterae* Pang and Chen 1974
" *ivelae* Pang and Chen 1974
" *leucaniae* Pang and Chen 1974
" *fasciatum* (Perkins) 1912
" *minutum* Riley 1921
" *lingulatum* Pang and Chen 1974
" *poliae* Nagaraja 1973
" *raoi* Nagaraja 1973
" *sericini* Pang and Chen 1974
" *euproctidis* (Girault) 1911 (doubted by Pinto et al., 1978)
" *polychoris* Chen and Pang 1977
" *caccoaecae* Marchal *
" *pretiosum* Riley *

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*Recently imported; + most common species; # may be synonymous to *confusum*.

APPENDIX 2

BENEFICIAL ARTHROPODS: RICE FIELDS AT DASHA PEOPLE'S COMMUNE GUANGDONG PROVINCE

List of spider species collected from rice fields in the Dasha People's Commune, Guangdong Province, insect collection:

Tetragnatha japonica	*Theridion octomaculatum*
T. javana	*Erigonidium graminicolum*
T. nitens	*Pirata piraticus*
Theridium sp.	*Laucauge* sp.
Erigoneptomines sp.	*Oedothorax insectipes*
Clubiona japonicola	*Micryphanta* sp.
Lycosa pseudoannulata	*Oxyopes sertatus*

List of parasite species of rice pests seen in the Dasha People's Commune, Guangdong Province, insect collection:

Apanteles cypris	*Temelucha philippenensis*
Elasmus sp.	*Brachymeria excarinata*
Cardiochiles sp.	*Xanthopipla flavilineata*

Spiders, the lady beetle (*Verania discolor*), the carabid (*Ophionea indica*), and the parasite (*Xanthopipla flavilineata*) were most abundant in the rice fields.

APPENDIX 3

LIST OF PARASITES OF RICE PESTS

Apanteles baoris	*A. cypris*
A. kariyae	*A. ruficus*
Macrocentrus sp.	*Temelucha philippinensis**
Eriborus sinicus	*Coccygominus nipponicus*
Xanthopimpla flavolineata	*X. punctata**
Bracon onukii	*B. chinesis*
Tropobracon schoenobii	*Chelonus nunakatae* or
Rogas narangae	*Chilo supraralis*
Tetrastichus schoenobii	*Mesochorus discitergus*
*Ischnojoppa luteator**	*Telenomus rowani*
Charaps bicolor	*T. dignus*
Diplozon laetatorius	*Paracentrobia andoi* (Ishii)
Vulgichneumon leucaniae	*Anagrus flaveolus*
Diadegma akoensis	*Lymaenon longicrus*
Chlorinaeus sp.	*Centeterus alternecoloratus*
Trichogramma japonicum	*Itoplectis narohyae*
T. dendrolimi	*T. evanescens*
T. chilonis	

*Most commonly encountered.

APPENDIX 4

DOMINANT SPIDERS OF HUNAN

Erigonidium graminicolum Sundevall 1829
Theridion octomaculatum Boes. et str. 1906
Lycosa pseudoannulata Boes. et str. 1906
Pirata subpiraticus Boes. et str. 1906
Tetragnatha japonica Boes. et str. 1906
Tetragnatha shikokiane Yaginuma
Neosconia theiss (Walckenaer)

APPENDIX 5

FIVE SERIOUS PESTS IN HUNAN PROVINCE

Yellow rice borer	*Scirpophaga incertular* (Wk.) (= *Tryporyza*)
Asiatic rice striped borer	*Chilo suppressalis* Wk.
Rice leafroller	*Cnaphalocrocis medinalis* Guen
Brown planthopper	*Nilaparvata lugens* Stal
Green rice leafhopper	*Nephotettix cincticeps* (Uhler)

APPENDIX 6

CULTURE OF S. griseulus hangzhouensu AND EXTRACTION OF APHICIDIN

Spores are mixed with soil and sand (as a carrier) and placed in a media of 3 percent corn flour, 1 percent wheat bran, 1 percent soybean meal, 0.5 percent $(NH_4)_2\ SO_4$, 0.2 percent KNO_3, 0.5 percent $CaCO_3$, adjusted to pH 6.5 to 7.0. This is held at 28° C for 5 to 7 days, then shaken for 18 to 24 hours, then held for 20 to 24 hours. The content of corn flour is then raised to 7.0 percent and held for 45 to 72 hours. This is then filtered (to remove mycelia). The supernatant is made basic by the addition of 2 g of NaOH to 1000 g of supernatant. Aphicidin is very stable under basic conditions. The content of Aphicidin was reported to be 600 to 800 mg/liter.

For isolation of Aphicidin, the incubation mixture (aqueous) is reported to be "extracted" twice with 1 to 2 NaOH at 60° C, 4 hours each time. (The mixture is probably made basic and heated and the mycelia and solid components are "extracted" twice.) The combined extracts are extracted with ethyl acetate, dried over NA_2SO_4, concentrated under vacuum, and the Aphicidin is cleaned up on silica gel. The Aphicidin is elicited from a dry silica gel column with four to five columnar volumes of 5 to 8 percent ethyl acetate in benzene. Thin layer chromatography separations are done on silica with chlorogorm:methanol:benzene, 100:4:1.

STATUS OF INSECT TAXONOMY IN CHINA, WITH NOTES ON BIOLOGICAL CONTROL OF PESTS

by

Lloyd Knutson
Robert D. Gordon

CONTENTS

INTRODUCTION

There has been very little scientific exchange and technical cooperation between insect and mite systematists in the People's Republic of China (PRC) and the United States over the past 40 years. Few U.S. systematists have visited the People's Republic of China, and our knowledge of systematics activities in the People's Republic of China is extremely limited.

As a member of a seven-man biological control delegation to the People's Republic of China in 1979, Mr. J. R. Coulson [Chief, Beneficial Insect Introduction Laboratory (BIIL), Insect Identification and Beneficial Insect Introduction Institute (IIBIII)] obtained some information about collections, taxonomists, and research projects, particularly in relation to natural enemies of pests. In the same year, Dr. D. R. Davis (then Chairman, Department of Entomology, Smithsonian Institution) visited the People's Republic of China as the entomologist on a 12-man Smithsonian team of specialists in various animal and plant groups and gained considerable information during visits to six Chinese institutions. In 1981, Dr. P. M. Marsh [Chief, Systematic Entomology Laboratory (SEL)] and Dr. E. E. Grissell (Research Entomologist, SEL) visited the People's Republic of China to begin explorations of possibilities for USDA-PRC cooperation between the U.S. Department of Agriculture (USDA) and organizations in the People's Republic of China in the area of insect and mite systematics. A few individual U.S. entomologists with taxonomic interests have also visited the People's Republic of China in recent years, including Dr. P. H. DeBach (University of California, Riverside) who searched for natural enemies of scale insect pests in 1981. Some information on natural enemies of interest to taxonomists was obtained by the 1981 Forest Pest Protection Team.

Likewise, several PRC insect and mite systematists have visited the United States recently. In 1980, Dr. Zhao Xiufu (Fujian Agricultural College, Shaxian, Fujian Province) visited several U.S. institutions, including SEL and the Smithsonian Department of Entomology as a member of the PRC reciprocal biological control delegation. Yu Zhiren of the Citrus Research Institute, Chongqing, Sichuan Province, recently studied Phytoseidae at the University of California, Riverside. Madame Wang Zunming (Mrs. Li Tiesheng), a specialist in Tabanidae at Academia Sinica, Beijing, recently completed a 1-year study visit at the Department of Entomology, Oregon State University. Dr. Pang Xiongfie, a specialist in *Trichogramma* and *Coccinellidae* at the South China Agricultural College, is spending about 1 year in the BIIL working on *Trichogramma* with Dr. A. C. F. Hung of BIIL and on Coccinellidae with Dr. R. D. Gordon of the SEL. Mr. Guan Lianghua, a specialist in stored-product pests, plans to study beetles in the SEL in 1982.

As a part of the US-PRC Scientific and Technical Exchange Agreement, we visited several research and educational institutions in the People's Republic of China during the period of May 12-June 3, 1981 to:

- Exchange information in the areas of (primarily) insect and mite systematics, and (secondarily) biological control of pests by natural enemies,

- Clarify procedures that could be used in conducting cooperative research in the systematics of insects and mites, particularly those taxonomic groups of importance to biological control,

- Identify potential cooperative research projects, researchers, and locations in the areas of systematic entomology and acarology, and

- Establish direct, official contact with systematic entomologists and biological control workers in the People's Republic of China.

These matters were discussed with over 300 entomologists and research leaders of 12 institutions in 5 cities during the 20 days we spent in the People's Republic of China. In addition, colonies of living natural enemies were taken to the People's Republic of China and were brought back to the United States, a large number of entomological publications were exchanged, and valuable scientific contacts were established.

The observations in this report, as well as our suggestions and evaluations, are written to further productive collaboration and actual joint research between the United States and the People's Republic of China.

SUMMARY STATEMENTS

1. Cooperation in Taxonomic Research

Cooperative taxonomic research between IIBIII and PRC scientists has been part of the planning of the biological control aspect of the US-PRC Scientific and Technical Exchange Agreement since the Agreement was established in 1979. Taxonomic research on insects and mites of importance to, but not limited to, biological control interests has been considered of value not only in itself, but also because research in this area should enhance cooperative research in other areas of biological control.

Discussions in the People's Republic of China by J. R. Coulson and others in 1979, in the United States with the PRC delegation in 1980, and again in the People's Republic of China by P. M. Marsh and E. E. Grissell in 1980 provided some indications as to how cooperative research in systematics might be conducted. However, until the current trip, there has been no clear understanding on the U.S. side as to how to proceed. As a result of our visit, we believe that most of the essential questions, except the matter of coordinators, have been answered, and it is now possible for IIBIII and other taxonomists to conduct cooperative research in the People's Republic of China. Further "fact-finding" missions are unnecessary. What is needed at this point are one or more relatively short visits to the People's Republic of China by IIBIII and other scientists, and visits to U.S. institutions of several weeks to a few months by Chinese taxonomists, resulting in jointly authored papers published in a Chinese journal in the very near future.

Identification of coordinators for IIBIII-PRC cooperative taxonomic research remains unresolved and should be settled in the near future. Prior to our trip, we were told that Dr. Qui Shibang (Biological Control Laboratory, Chinese Academy of Agricultural Sciences, Beijing) was the coordinator on the Chinese side. When we arrived in the People's Republic of China, we were informed by Dr. Qui that he is not a coordinator for taxonomic research. We discussed this matter and other aspects of the US-PRC agreement with Dr. Qui during a 1-hour visit on June 1. He agreed with our suggestion that there should be a coordinator, and he suggested that this person be from the Academia Sinica. We also suggested that since the taxonomic interests and needs relative to agriculture in the People's Republic of China are, naturally, best understood in the Ministry of Agriculture and the Academy of Agricultural Sciences, the coordination on the Chinese side should include representatives from those agencies as well as from Academia Sinica. Since the IIBIII involvement in cooperative taxonomic research is primarily under the US-PRC Scientific and Technical Exchange Agreement, it is logical that our primary contacts be with agricultural interests in the People's Republic of China. Also, since the Smithsonian Institution has an agreement with the Academia Sinica, and since the nature of that agreement is, at least in part, different from that of the US-PRC Agreement, it may be appropriate to have separate coordinating procedures.

The following 14 questions regarding cooperative taxonomic research were prepared by Knutson before our visit to the People's Republic of China. Most of the questions were discussed with Chinese scientists:

1. What are the taxonomic groups that need to be researched?

2. Which PRC and U.S. taxonomists have expertise in these areas?

3. Has there been communication between these taxonomists, relative to the identified needs?

4. Do the taxonomists' research plans and other factors permit cooperative research to be initiated?

5. What is the nature and extent of cooperation anticipated by the People's Republic of China and the United States?

6. How much time, working cooperatively in the People's Republic of China and/or the United States, is needed for each project?

7. Can a tentative list of research projects and the researchers involved be prepared?

8. Can a tentative time schedule be prepared?

9. Are collections, in the People's Republic of China and the United States, adequate for the research?

10. Is field collecting in the People's Republic of China and/or the United States necessary?

11. What are the PRC requirements vis-a-vis deposition of type material and other specimens?

12. What are the PRC interests regarding the journals used for publishing cooperative research papers?

13. To what extent is the cooperative research to emphasize insects and mites of importance to biological control?

Although both sides have previously indicated an interest in cooperating on taxonomic research on parasitic wasps (Hymenoptera), options for the first cooperative project should not be limited to this group. As noted above, our immediate objectives are to conduct relatively brief cooperative projects, complete to the extent of joint publication, and in the near future, to establish the broad taxonomic research agreement on a positive, firm basis. Thus, the availability of the appropriate taxonomists is critical. Also, in the course of our visit, it became obvious to us that additional factors, such as the scientists' ability to communicate effectively with the Chinese scientists, would be essential to the development of a productive cooperative relationship.

The location at which the U.S. scientist would spend most of his/her time working in the People's Republic of China would be determined largely by the location of the appropriate counterpart in the People's Republic of China, the study-environment, the nature of the cooperation expected, and the logistics of local travel and need for (possibility of) collecting in the field. In any case, the taxonomist may need to spend one or more days studying the Academia Sinica collections in Beijing and Shanghai (and possibly

in one or more other locations, where there are specialized collections), to select unidentified specimens from unsorted collections. One of the best work locations that we visited, with regard to the above criteria, was the North West Agricultural College at Wugong, near Xian, Shaanxi Province.

Prior to the arrival of the U.S. scientist in the People's Republic of China, plans should be made to have as much material as possible of the group of insects or mites to be studied sent to the main study location. The Chinese are prepared to do this, and in fact had begun to make arrangements for consolidating collections of Ichneumonidae, Braconidae, and Chalcidoidea in Beijing in April 1981. Also, it may be useful to attempt to have new material collected in certain areas, especially where there are Chinese specialists in the group of interest, before the U.S. scientist goes to the People's Republic of China.

2. Collections, Collecting, Publication, and Work Procedures

One of the major difficulties that Chinese taxonomists face is lack of access to type specimens; many types are in overseas museums, and Chinese taxonomists, like U.S. taxonomists, have limited opportunity to travel because of limitation of funds. Thus, all taxonomists with whom we spoke were in strong agreement that holotypes resulting from future research must be deposited in the People's Republic of China. The possibility that new species will be described and the types not returned to the People's Republic of China is of great concern and contributes to the policy of not lending unidentified material for study. We assured our Chinese colleagues that the matter of holotypes was not a problem, and that, especially over the past 10-15 years, it has become a standard policy throughout the world to return types to the country of origin. (Violation of this policy would jeopardize the cooperation between the U.S. and the PRC scientists.)

The policy of not lending unidentified material could be a deterrent to effective cooperation. The development of good contacts between Chinese and U.S. taxonomists may further such borrowing of material in the future.

The Chinese taxonomists seemed very interested in exchanging identified specimens. Substantial exchanges of such material in the near future will improve cooperation generally.

The date-locality and other labels on most specimens in Chinese collections are written in Chinese characters. This fact, of course, complicates a general overview inspection of a collection to locate research material or other specimens of interest. To overcome this difficulty, it will be useful, if not essential, for a Chinese scientist to work alongside the U.S. scientist. Chinese character labels on specific study material could be transliterated and keyed to numbers on a separate list for a relatively small group of specimens, but this laborious procedure could not be used in the important process of making an overview of a large collection to select unidentified material for study.

The development of insect systematics in the People's Republic of China has been somewhat limited because Western taxonomists have, naturally, been inclined to publish the results of their research on the Chinese fauna in Western journals. However, these journals are difficult or expensive to obtain in the People's Republic of China and papers published in Western

languages are not readily understood by many Chinese scientists at this moment in time. Although the younger generation of Chinese scientists are placing emphasis on learning English, and this generation as well as the older generation of scientists trained in the West would have no real difficulty with papers written in English, the current dominant age group does not have as much facility with English. Thus, for the next decade or so, it will be essential that papers written on Chinese insects by Western scientists be published in Chinese (as well as concurrently in English or some other Western language). This timeframe will likely be consistent with the ability of the Chinese to deal with the related problem of being able to purchase Western journals. It is apparent that until most Chinese scientists understand English and until Chinese institutions can afford to purchase Western journals, papers written about Chinese insects by non-Chinese scientists will need to be published in the Chinese language and in Chinese journals. Successful cooperative research projects will accelerate this process.

3. National Survey of Pest and Benefical Insects and Mites

Since the beginning of the US-PRC agricultural exchanges in biological control, we have been under the impression that there is a PRC "National Survey of Pest and Beneficial Insects and Mites." There is a "nationwide" survey (being carried out during 1979-80-81) that will result in a publication on pests and beneficials, but there is no highly structured survey. The 1979-81 survey is coordinated, to some extent, by the Ministry of Agriculture, which provides some instruction, but the actual work is performed in only some of the provinces. Apparently, after the current survey is completed, the results will be examined and the nature of the next survey determined. The taxonomists of Academia Sinica provide assistance in determining material within their areas of expertise. As far as we could determine, no procedures exist for obtaining identifications of groups for which there is no expertise in the People's Republic of China.

4. Procedures for Shipment of Natural Enemies

Scientists visiting the People's Republic of China should ask the airlines that service the People's Republic of China-Japan-United States route for more information on procedures for transporting live specimens. In the case of large or extremely important shipments, it may be wise for the person carrying live materials to have a letter from the head offices of the airline that would answer questions of staff at the airport.

The box of live insects that Knutson carried from Washington to Beijing was supplied with a small container of plastic-gel cooling substance, and Knutson carried a second container for recooling in flight. (The flight between San Francisco and Beijing took about 15 hours.) One of the containers was placed in the refrigerator on the airplane, but it was not possible to cool the plastic-gel effectively. It would be better in future flights to include in the box a zip-lock plastic bag containing ice cubes, which could be replenished during the flight. Such boxes should be appropriately prepared before departure.

During his one-day visit to Guangzhou, Knutson spent about 45 minutes learning about the care and feeding of the *Amblyseius newmani* mites that were to be hand-carried to the United States. The information could have been obtained *before* the actual visit, and the on-site visit could have been better

utilized. Since most entomologists have not had much experience in transporting live insects and mites between the United States and the People's Republic of China, it is essential, in the future, that the person(s) with knowledge about shipping (for example, the person receiving the material) provide the courier with all appropriate information.

5. Alternative Procedure for Obtaining Living Natural Enemies

Although a certain amount of biological control material is being obtained from the People's Republic of China via the existing exchange agreement, one of the USDA objectives is for scientists to travel in the People's Republic of China to study and collect such material. The suggestion that a Cooperative Agreement be established, whereby the United States would provide support for a PRC facility that would obtain natural enemies, conduct preliminary studies, and rear the natural enemies to the numbers and stages needed for shipment to the United States, was discussed with several biological control workers and administrators. Everyone was very interested in this idea and seemed to approve it in principle. Support for an existing Chinese laboratory, rather than other alternatives, would apparently be preferable.

6. Comments on Seminars

Seminars were held in the afternoons and lasted from about 2:00 to 4:30 or 5:00 PM. These were rather formal, and after a detailed introduction by the Department Chairman or one of the lead scientists, we presented our subjects. Although both of us made presentations on several subjects, the Chinese preferred that we present all of our information at one time, without questions from the audience. Then, after a 5- to 10-minute break, there was a question-answer period of 30-45 minutes. Once the discussions got going, they were rather lively, pleasant, and informal. Many of the questions were not directly related to the specific subject of our presentation, but were either rather general or about the Chinese scientist's special area of interest.

We tried to have all of the briefing sessions and seminars translated by the interpreter who accompanied us. Frequently, one of the scientists would clarify a technical term or description for the interpreter.

It is very desirable not to use thick, glass-mounted 2x2 slides, or at least not to combine paper- and glass-mounted slides. If possible, place the slides in the carousel or other equipment. Also, it is best to have slides on different subjects in separate small boxes to keep them from getting mixed up.

RECOMMENDATIONS

Systematics

1. PRC and USDA coordinators for research in the systematics of insects and mites should be designated in the near future.

2. One or more relatively short, cooperative research projects involving all steps in such an activity and resulting in jointly published papers, should be initiated as soon as possible as the most practical way of solving outstanding questions about cooperative work.

3. Exchange visits concerning systematics of *Matsucoccus* scales and Syrphidae flies should take place in FY 1983.

4. In order to move in the direction of establishing cooperative research, appropriate IIBIII taxonomists should initiate exchanges of *identified* specimens with colleagues in the People's Republic of China. Also, IIBIII scientists who have established contacts with systematists in the People's Republic of China may want to request loans of limited amounts of *unidentified* material of value to their current research projects.

5. A copy of the draft manual for identification of parasitic Hymenoptera by Grissel, Marsh, Masner, Menke, and Townes should be made available to Dr. Qui Shibang, Prof. Hu Cui, and colleagues for translation into Chinese, at the earliest possible opportunity.

6. A directory of PRC insect and mite taxonomists, with areas of expertise, should be published in the United States.

7. Reprints of publications by IIBIII taxonomists should be sent on a regular, routine basis to Academia Sinica, Beijing; Academia Sinica, Shanghai; North West Agricultural College, Wugong; and others.

Biological Control

1. The idea of U.S. support for a biological control facility in the People's Republic of China, to serve as a base for PRC scientists to search for, increase and study material of interest to the United States, should be further explored.

2. Procedures for obtaining and shipping living biological control material from the People's Republic of China should be prepared and provided to all potential travelers.

3. A directory of biological control researchers in the People's Republic of China, showing the areas of interest, should be prepared.

MAIN REPORT

BEIJING, MAY 15

Ministry of Agriculture

Mr. Hua Li (plant pathologist and Deputy Head of Biological Control, Bureau of Plant Protection, Ministry of Agriculture), Mr. Li Guoqiang (Director of Biological Control Station, Beijing Municipality), and Mr. Zhang Jingshui (interpreter, Bureau of Foreign Affairs, Ministry of Agriculture) met with us at the Friendship Hotel. Mr. Hua gave a detailed briefing on biological control work in the Ministry of Agriculture. There are three areas of emphasis:

1. Mass rearing and release
2. Introduction of foreign beneficials
3. Protection of natural enemies

(Note that this arrangement is just like that of the ARS National Research Program No. 20260 on biological control except that it does not include insect and mite taxonomy.)

1. Mass Rearing and Release

Trichogramma wasps are the most important natural enemies used in the People's Republic of China. The European corn borer [(Ostrinia nubilalis (Hübner)] (CB) is the most important pest. In the past one to two years, the Ministry has had to reduce the number of release areas for Trichogramma because of a manpower shortage.

a. Beijing release area: 800,000 mu (1 mu = 1/15 hectare)
b. Liaoning Province release area: 2.4 million mu
c. Shanxi Province release area: 400-500,000 mu

Most work is performed locally. Mr. Hua's office is responsible for direction and financial support. Corn is more important in North than in South China, where it is second to rice in importance.

In the 1960's, Dr. Qui Shibang studied the use of spiders and chalcids as biological control agents. In the 1970's, Trichogramma was developed as a natural enemy of the CB because use of a new, taller variety of corn for interplanting required changes in chemical control procedures. That is, hand application of granular insecticide, which was possible with the old variety of short, spring corn, was difficult with the tall variety. The Pernyi (Eri) silk moth previously was used as a host in the rearing of Trichogramma, but now the rice moth [Corcyra cephalonica (Stainton)] is used. In Guangdong Province, Trichogramma has been used to control sugarcane borers. The Eri silk moth (host - castor bean plant) is used for rearing Trichogramma in Guangdong.

Anastatus is now used against sugarcane borers, and it is also used against the stinkbug pest of lichee. New developments in rearing *Anastatus* are based on the need to be economical and on new technology. These problems have not been solved. It is now difficult to find hosts of *Anastatus*. Growing host plants is a problem in raising *Anastatus*, and research on an artificial diet for *Anastatus* is underway.

Dr. Qui Shibang is also working on *Chrysopa*, but this work is not being conducted in an extensive test area. *Chrysopa* are also being studied in Hunan Province, where the cotton bollworm is a major pest. Recently, researchers have established environmental requirements for *Chrysopa*. Phytoseiid mites are successfully used in Guangdong Province to control red spider mites, especially in mountainous areas. However, control by mites is not successful in the dry plains of North China. A "green manure" technique has been developed and is being integrated with chemical control. Flowers of green manure (*Ageratum conyziodes*) were found to be a good reservoir of mites by Huang Mingdu (Biology Department, Zhongshan University). Green manure is grown between rows in citrus orchards, not as a crop, but to support the mites.

2. *Introduction of Beneficial Insects*

Qui Shibang is in charge of introduction and exportation of beneficials. The Ministry of Agriculture asked Dr. Qui to organize and supervise this work in the People's Republic of China. Researchers in foreign countries should contact this Institute in regard to exchanges, and Dr. Qui will make the contacts. Dr. Qui noted that, "China has rich resources in beneficials." Chinese scientists have been working in this area for only 2 years, and the manpower and facilities cannot meet the needs.

Recent introductions into the People's Republic of China include a coccinellid beetle from Australia (*Cryptolaemus montrouzieri* Mulsant) that preys on cottony cushion scales, and *Aphelinus* sp. parasitic on apple aphids (both are successfully established). *Encarsia formosa* Gahan has recently been introduced from England to control whiteflies in vegetable crops. It is not established, except under greenhouse conditions. We were told that theoretical, ecological research has been neglected in the People's Republic of China in recent years, but Chinese scientists believe that this area must be emphasized in the future. The situation is improving now, partly because there is a biological control laboratory. Needs include research on the fauna of pests and beneficials and on the ecology of pests in the crops.

3. *Protection of Natural Enemies*

This is the most important area for future work in the People's Republic of China, especially with regard to Integrated Pest Management (IPM). IPM was established as a procedure in the People's Republic of China in 1975. One aspect of IPM is to study the ecology of agricultural lands.

National Survey of Pest and Beneficial Insects and Mites. This survey was started in 1979. The Bureau of Plant Protection in the Ministry of Agriculture coordinates and provides instruction, and 26 provinces and municipalities are involved. Some agricultural colleges and universities are also involved. Academia Sinica provides some assistance with identifications. The purpose of the survey is not to find new species or to treat all species in an area, but to survey for agriculturally important insects in selected areas. The entire country is not involved, but only a number of provinces. After the third year, the results will be summarized in a book on the main pests, natural enemies, and crops. Then the survey will be continued, but modified. Many problems are involved, one of which is identification, although identification of predators is not a serious problem. Mr. Hua felt that the survey should emphasize biologies, life cycles, and natural enemies.

The Ministry of Agriculture plans to develop a system to forecast information on beneficial insects. Forecasting has been developed for pests.

In plant protection in North China, especially for cotton and grains, ecological studies need to be considered particularly because of intercropping practices. For example, in rice-growing areas, farmers plant "green manures" to establish populations of mites. In paddy rice, there is one mite to five pest individuals; in late rice, there is one mite to eight pests. In these situations, there is no need to use insecticides. In this system, reduction in the use of pesticides is emphasized to protect mites. Also, by using *Trichogramma* wasps against CB, other natural enemies are also protected. In Hubei Province, hand labor is used to remove pests to protect beneficials. The main pests of cotton in North China are aphids at first, and bollworms later in the season. Integrated control is used, with as little insecticide treatment as possible.

Regulatory Entomology Collections. Knutson gave Mr. Hua a collection of North American insect pests. We were told that communication about exchange of reference specimens of species of interest to regulatory entomology should be sent to Mr. Ji Liang (pathologist), Director, Institute for Plant Quarantine, Ministry of Agriculture, Beijing; and to Mr. Chen Zhong Mei (entomologist), Head of Division of Plant Quarantine, Bureau of Plant Protection, Ministry of Agriculture, Beijing. There are 36 plant quarantine stations in the People's Republic of China.

Biological Control Laboratory, Academy of Agricultural Sciences, Beijing,

Dr. Qui Shibang, Director
Ms. Tian Yugi, Deputy Director
Ms. Lee Pingshu
Mr. Zhu Jianming
Mr. Yu Jiujun (Working on nematodes parasitic on *Heliothis*, obtained from Australia. Project is in the early stages of development).
Mr. Wang Ren

The laboratory was established in 1980. The staff consists of 30 scientists, 10 assistants, 10 students, and 3 graduate students. The program is oriented to applied research, more than most U.S. laboratories.

Taxonomy is practiced mainly by the members of Academia Sinica and the universities. The Academy of Agricultural Sciences apparently plans to develop its own taxonomic expertise eventually, but at the present there is a shortage of manpower.

Projects undertaken by the Biological Control Laboratory are:

1. Introduction of foreign natural enemies.

2. Chrysopa rearing and release (Ms. Lee Pingshu). Procedures are not mechanized; pint jars with a gauze cover and plastic strips to prevent cannabalism are used; rice moth eggs are used as the host. One hundred eggs in a bottle produce 60 to 70 percent cocoons. Material is reared in bottles or in boxes for larger quantities. Each box can produce 2,000 cocoons at a 50 percent survival rate. The boxes are useful for extension activities. Ten species of Chrysopa (green lacewings) occur in the People's Republic of China, five of which are cultured in this lab: C. sinica Tjeder, C. septempunctata Wesmael, C. formosa Brauer, C. phyllochroma Wesmael, and C. carnea. An artificial diet (soya bean powder and vitamins) is used.

3. Introduction of Encarsia formosa: This parasite of whitefly larvae was introduced into the People's Republic of China from England in 1978. The laboratory provides starter colonies for greenhouses. The whitefly has a host range of about 90 species in 11 genera. It is being reared at 27° C and 70 percent RH.

4. Trichogramma - Reared on eggs of oak silkworm [Antheraea pernyi (Guerin-Meneville)], and 50-100 Trichogramma are obtained from each egg. Philosamia cynthia ricini (Boisduval) (=Samia c.r.) (Eri silkworm) is also used as a host.

Mr. Li Guoqiang noted that the following people are working on biotypes of Trichogramma: (1) Zhang Jin, Shengyang Agricultural College; (2) Huo Shaotung, Academy of Agricultural Sciences, Shaanxi Province; and (3) Feng Jiunguo, Academy of Agricultural Sciences, Shandong Province.

BEIJING, MAY 16

Division of Forest Entomology, Research Institute of Forestry, Chinese Academy of Forestry

The Institute is situated about one-half hour by car from the center of Beijing. It was also visited by the 1981 OICD-SAF Forest Pest Protection Team. The following is a list of the staff members and their disciplines:

Scientist	Research Area
1. Xiao Guangrou (Hsiao Kangjou)	Taxonomy of Symphyta, forecasting of forest insect pests, and natural enemies (Director, Division of Forest Entomology)

Scientist	Research Area
2. Hung Xiaoyun	Taxonomy of Symphyta (Deputy Director, Division of Forest Entomology)
3. Li Guanwu	Taxonomy of Symphyta
4. Ms. Yang Xinyuan	Identification of quarantine pests
5. Qin Xixiang	Control of cerambycid beetle pests of poplars
6. Sui Xilin	*Matsucoccus* scales
7. Zhou Shuzhi	Taxonomy of Symphyta
8. Yan Jingjun	Application of natural enemies, *Arama chinensis*
9. Xu Chonghua	Application of natural enemies, *Arama chinensis*
10. Yao Defu	Application of natural enemies, *Arama chinensis*
11. Chen Changjie	Viruses of forest insects
12. Wang Zhixian	Viruses of forest insects
13. He Jietian	Viruses of forest insects
14. Cui Shiying	Viruses of forest insects
15. Li Zhaolin	Research on *Bacillus thuringiensis*
16. Wang Guicheng	Virus research
17. Zhang Beiyi	Insect illustration
18. Hou Yanqui	Endangered species
19. Wang Xuipin	Research on *Bacillus thuringiensis*
20. Dai Lianyun	Research on *Bacillus thuringiensis*
21. Zhang Shimin	Survey of the insect fauna of poplars
22. Tian Shuxia	Endangered species
23. Zhang Fuyan	Endangered species
24. Yang Ruoli	Endangered species
25. Wu Jian	Insect identification
26. Gao Wenchen	Lady beetle rearing and *Matsucoccus* control
27. Li Yingmei	Natural enemies
28. Zhao Ling	Chemical control
29. Gao Luitong	Control of cerambycid beetle pests of poplars
30. Liang Chegjie	Chemical control
31. Li Tiansheng	Ecology of insects
32. Liang Chongqi	Endangered species
33. Wang Wei	Forest insect viruses
34. Wang Wei	Endangered species

Dr. Xiao Gangrou was in Hubei Province at the time of our visit. The discussion was led by Yan Jingjun. The staff consists of 33 researchers plus 4 support staff. Primary research areas are as follows: (1) Viruses, (2) *Bacillus thuringiensis*, (3) natural enemies of forest pests, (4) ecology, (5) chemical control, (6) taxonomy of Symphta (sawflies), (7) Japanese bast scale (*Matsucoccus matsumurae* (Kuwana) and cerambycid beetle pests, and (8) Endangered species (Giant panda, etc.).

Natural enemies research area: Dr. Xiao Gangrou, Ms. Yang Xinyuan, Hung Xiaoyun, and Zhou Shuzhi. Also, five other people work on related areas:

1. Pine caterpillar (*Dendrolimus punctatus* Walker) is a major pest of *Pinus massoniana* Lamb. This is the main project.

2. Mantis: Biology in Populus forests; plan to release egg masses in forests.

3. Sclerodermus sp. (Bethylidae) is a parasite of Semanotus bifasciatus (Motsch.) (Cerambycidae), a pest of Chinese fir (Cunninghamia lanceolata). This parasite has achieved good control in South China.

4. Coccinellidae against Japanese bast scale: Ballia obscurosignata (Liu), Exochomus mongol Barovsky, and Leis axyridis (Pallas) (=Harmonia axyridis). In Zhejiang Province, there are 19 species of coccinellids on Pinus.

5. Survey of pest and beneficial insects on Salix sp. and Populus tuskumus. (Populus is the main tree in North China; Pinus is the main tree south of the Yangtze River.)

6. "American white moth" (Fall webworm) (Hyphantria cunea (Drury)). Now established in eight counties in Liaoning Province in Northeast China, it was first found 2 years ago. The Ministry of Agriculture and Academy of Forestry are now organizing a research program. There is great concern about H. cunea as an apple pest, since it has been found on Acer negundo and apple. The Chinese are now using protective containment and chemical control.

7. Arama chinensis Fallén (Pentatomidae). The Ministry of Agriculture and Academy of Forestry are now cooperating on biological control of this stinkbug. In the future, the Academy of Forestry will develop its own program. Mr. Yan Jingjun is working on this project, and he is interested in putting this pest on the list of Chinese needs for biological control exchange.

   They stated that they want to exchange natural enemies with researchers in the the United States in the future, and they requested a list of names of species that we would like to have. They anticipate having their own biological control program soon, complete with a quarantine facility.

Institute of Zoology, Academia Sinica

There are 10 laboratories in the Institute, 6 of which are concerned with entomology:

1. Ecological Entomology - Major pests of the People's Republic of China; ecosystems of grasslands.

2. Insect Physiology - Studies of nutrition, metabolism, juvenile hormones and artificial rearing of Trichogramma and Chrysopa.

3. Insect Pathology

4. Toxicology - Work on the development of resistance and its control and on the structure of agrichemicals and their activities.

5. Insect Pheromones - Work on identification of chemical structures. The active ingredients in materials produced by pine caterpillar and oriental fruit moth were recently studied. Pheromones are being used in control.

6. Insect Taxonomy - 60 staff, 15 at the Professor and Associate Professor levels. Since 1949, the main emphasis of this Institute has been on taxonomy. The main objectives are the major pests of agriculture and forestry and beneficial insects and mites.

Additional Notes

With regard to natural enemies, special emphasis is placed on the Tachinidae and the Chalcidoidea. A book on pests and natural enemies is being produced as a result of the 3-year nationwide survey.

There are 2 million boxes of specimens in the collection. Specimens cannot be borrowed.

Discussion with Dr. Chu Hung-fu (Deputy Director):

1. Academia Sinica, Beijing has a large stock of their journals, which they are interested in exchanging for U.S. journals.

2. We discussed the general subject of cooperation. Dr. Chu asked about support for Chinese taxonomists to work in the United States. We gave Dr. Chu a list of basic proposals for having an SEL scientist work in the People's Republic of China.

3. Types must be placed in the People's Republic of China. Neither identified nor unidentified specimens can be borrowed.

BEIJING, MAY 18

Institute of Zoology, Academia Sinica

We met Mr. Chen Tailu, a *Trichogramma* specialist. We delivered specimens and a letter from A. C. F. Hung (Beneficial Insect Introduction Laboratory, IIBIII, USDA, Beltsville), picked up specimens of four new species of *Trichogramma* and copies of photos of genitalia, and promised to send Mr. Chen a copy of L. Ertle's manuscript bibliography. Mr. Chen is using length of ovipositor and hair on the thorax as taxonomic characters.

Volume I of *Insects of Tibet* (Lepidoptera and Coleoptera) will be published in 1981; Volume II, in 1982.

Knutson had a useful discussion with Mr. Liao Tingshi on scale insect pests and their parasites. Prof. Gjoan Yuwein (Djou Yu-Wen) studied parasites of scales 30 years ago with Dr. J. L. Gressitt at Lingnan University. Prof. Gjoan is now at Zhongshan University. His study material has been destroyed. Parasites of the white peach scale (which is common in North China) are: *Apterencyrtus* sp. (primarily a hyperparasite) and *Anabrolepis* sp. (Encyrtidae).

The North American Prospaltella also occurs in the People's Republic of China. The San Jose scale is very scarce in the People's Republic of China; it has been seen only 3 times by Mr. Liao. Eussuria sp.? (a parasite of San Jose scale) is in Dr. Tryapitzin's collection in Leningrad; this species is known from Far Eastern SSR and may also be in North China or Korea, according to Mr. Liao. The Chinese species of Prospaltella may not be perniciosi Tower; the Chinese species of Coccophagoides may not be kuwanae (Silvestri). Euonymus scale in South China is distributed with citrus.

XIAN-WUGONG, MAY 19

North West Agricultural College, Wugong

Prof. Chou Io described the program of the Plant Protection Department, and gave us a publication on North West Agricultural College.

The North West Agricultural College was established in 1934. It has eight departments (agronomy, plant protection, pedology and agrochemistry, horticulture, agricultural machinery, hydraulic engineering, animal husbandry and veterinary medicine, and agricultural economics). Its library has more than 500,000 volumes. The college has 1,800 students, and 642 teachers of various ranks, including 86 full and associate professors.

The Plant Protection Department has two groups: plant disease and entomology. There are 14 teaching staff (1 Professor, 2 Associate Professors, 8 lecturers, and 3 associates).

The entomology curriculum includes: (1) general entomology, (2) agricultural entomology, and (3) horticultural and agricultural pests combined. The entomology section works closely with the Horticulture and Agronomy Departments.

In the entomology section, there are 210 students, 3 postgraduates, and 4 "advanced learning trainees." There are about 60 graduates a year in entomology. [Note: postgraduate work in entomology is given at Wugong, Nanjing, South China Agricultural College, Southwest Agricultural College, Beijing Agricultural College, Shenyang Agricultural College, Zhejian (Chekiang) Agricultural College, and Huazhong Agricultural College (Central China).]

Entomology research emphases at Wugong are: (1) Insect taxonomy, (2) insect physiology, and (3) chemical control of pests.

1. Insect Taxonomy Research Areas (and recent extent of activity)

Homoptera
- Membracidae (6 papers; 3 new genera, 13 new species)
- Fulgoroidea (8 new species)
- Diaspididae (4 papers; 1 new species)
- Aleyrodidae

Lepidoptera

Rhopalocera (3 papers)
Plusiinae (6 papers; 6 new genera, 21 new species)
Drepanidae
Cossidae
Yponomeutidae

Coleoptera

Cerambycidae (1 paper)
Coccinellidae (2 papers, including "Key to Lady Beetles of Shaanxi Province")
Scarabaeidae

Diptera

Syrphidae (no papers but work is underway)

Mecoptera (most advanced area of study in the Section)
(1 paper; 12 new species (mainly *Panorpa*). Only 6 species were previously known from the People's Republic of China)

Neuroptera (1 paper, on Chrysopidae)

Hemiptera

Nabidae (Mr. Lu Jinsheng)
Anthocoridae

Orthoptera (2 papers)

Locustidae (1 paper; 2 new genera, 3 new species)

Apterygota (5 papers; 2 new genera, 7 new species)

Acarina (2 papers)

We were given a copy of "History of Chinese Entomology."

Research on Insect Pests

1. Wheat midge (*Sitodiplosis mosellana* (Gehin). The species has been a serious pest since 1949. It has been studied for 3 years. Previously, losses were 80 percent; now they are only 1 to 2 percent because of the use of chemical control, resistant varieties, and parasites (Chalcidae).

2. Pea weevil [*Bruchus pisorum* (L.)]. This insect is a stored-product pest. Simple methods are being utilized for control: an outer container with wheat bran and an inner container filled with infested peas. Heat produced by the bran in the outer container kills the *B. pisorum* larvae in the inner container.

3. Wheat stem fly (*Meromyza saltatrix* (L.).

4. Apple borer (*Agrilus mali* Matsumura)

5. May beetle (*Holotrichia sauteri* Moser)

6. San Jose scale. This insect was formerly a serious pest but is now controlled with a coccinellid. The coccinellid specialist, Mr. Wei Jianhua, said that *Rodalia cardinalis* (Mulsant) is responsible for the control, and both the scale and the beetle are rare.

7. Rice pest (*Oulema oryzae* (Kuwayama). Feeds on roots.

8. A wireworm (*Pleonomus caniculatus* (Faldermann).

Information on all of the above has been published.

Insect Collection: 200,000 specimens, mainly from Shaanxi Province, but many have been collected from all provinces. Six rows of 40 cabinets/row, with 12 drawers per cabinet for a total of 2,880 drawers. Two cabinets of Diptera, one from Shaanxi Province and one from other areas.

Entomotaxonomia: Financial support is received from the National Government. Volume 1 (Nos. 1 and 2) were published in 1979. Volume 2 (1980) will consist of 4 numbers, 2 of which have been published and mailed, and the remaining 2 were scheduled to be published in May 1981. Nos. 1 and 2 of Volume 3 (1981) are at the printers. The idea for this journal was put forward at an Entomological Congress. There are two other Chinese journals in which insect taxonomic research can be published: *Acta Zootaxonomia Sinica* and *Acta Entomologica Sinica*. *Entomotaxonomia* was needed because insect taxonomy papers have had a 2 to 3 year backlog. There were few journals for taxonomy before 1949.

Editorial Board (22 people):

United States	P. Wygodzinsky and T. C. Maa
United Kingdom	L. Mound
India	A. S. Mani
Denmark	S. L. Tuxen
Japan	S. Takagi and R. Yosii
Italy	Tremblay
China	14 people (including the President of the Entomological Society of China)

Editors: Chou Io and Lu Jinsheng

Extensive exchange relations with 180 institutions in 40 countries have been established. Summaries are published in English and other languages. Foreign contributions on Chinese insects are welcome. The emphasis of the journal is on basic studies in taxonomy and theoretical studies.

Academia Sinica sponsors work on Plusiinae, Apterygota, Cercopidae, and Mecoptera at Wugong. For this work, specimens from other institutions are used.

Additional Notes

It was found that it is typical for Chinese taxonomists to borrow material within the country; that Chinese museums have generally not loaned specimens to taxonomists in other countries, but that they may in the future; and that loans should be processed through government channels.

Prof. Chou said that before 1949, when foreign scientists collected in the People's Republic of China, they published in foreign journals and the types usually were kept in foreign museums. This created problems for Chinese taxonomists. Prof. Chou stated there were essentially three major problems for Chinese taxonomists:

1. Many type specimens are in foreign museums, and reference material in general is not available in the People's Republic of China. He re-emphasized that specimens (types) must be deposited in the People's Republic of China and the papers must be published in the People's Republic of China.

2. Publications are in English or some other poorly known foreign language.

3. Foreign journals are difficult to obtain.

We presented our proposal for a USDA taxonomist to study at Wugong. Prof. Chou said that he agreed with this proposal in principle, but it needs government approval, and he wants Chinese students to study in the United States. We said that our interests are to have a USDA taxonomist work at Wugong and in a few other places (for example, Beijing and Shanghai) for a total of 3 to 6 weeks in 1982.

Prof. Chou then stated what he felt should (would) be the People's Republic of China conditions for cooperative work:

1. It must be of 1:1 benefit (it must be of equal benefit to both U.S. and Chinese taxonomists and departments).

2. Publication must be in Chinese and in English, in a Chinese journal.

3. The holotype specimens must be deposited in museums in the People's Republic of China.

We replied that we agreed with these conditions, but we represent only the U.S. Department of Agriculture, so we cannot speak, officially, for other taxonomists or groups of taxonomists. However, we said that these are typical working procedures for taxonomists, and we could see no difficulty with others being able to agree to them.

Prof. Chou noted that these are his personal ideas. However, even if not precisely the same, they are certainly representative of the attitudes of most other Chinese taxonomists.

We asked if it was possible to <u>exchange</u> literature and specimens without special permission. Prof. Chou replied that no permission is required for exchange of literature or identified specimens (the latter must be on a 1:1 basis) but that unidentified specimens may not be sent out of the country without going through the official channels.

We asked about a "Directory of PRC Insect Taxonomists." They replied that no such directory is being prepared. However, Mr. Yang Chikun, Beijing Agricultural University, is preparing a directory of taxonomists working on biological control material. A draft of this directory was distributed to students in a recent biological control course, but it has not been published.

Gordon gave an overview of SEL research. He suggested that an article on insect taxonomy research in the People's Republic of China be published in the ESA Bulletin of the Entomological Society of America and in Entomotaxonomia.

Knutson described the need for research on biosystematics of *Trichogramma* in the United States, and the Chinese taxonomists indicated that they had similar needs.

In the evening we had a 1-1/2 hour discussion with Dr. Wan Jianzhong (Dean of the Agricultural College), Prof. Chou, and Mr. Lu. Dr. Wan spent 4 years at the University of Wisconsin in the 1940's. We recapped the day's discussions and, in general, Dr. Wan agreed with the results of our discussions. Prof. Chou made a point of discussing the criteria regarding loan and exchange of specimens; we noted that we did not have any difficulty with these criteria.

SHANGHAI, MAY 23

Meeting at Shanghai Botanical Garden

Mr. Lu Youfung - Plant Protection Station
Ms. Xe Huiling - Plant Protection Station
Ms. Wu Hsiaoching - Garden Scientific Research Institute
Mr. Sun Chinung - Shanghai Botanical Garden

Staff are not taxonomists, but are mainly involved in local surveys and studies of pests and natural enemies in the Shanghai area. They are urban entomologists, working on garden and ornamental pests, especially in parks. Specimens are prepared at the Botanical Garden for the Plant Protection Station. The agricultural pest survey begun in 1979 includes 10 counties around Shanghai. So far, the survey has shown that there are many natural enemies.

Major Pests	Natural Enemies
1. *Cnaphalocrocis medinalis* (Guenee)	1. *Apanteles cypris* Nixon *Trathala flavoorbitalis* (Cameron)
2. *Pectinophora gossypiella* (Saunders) (pink bollworm)	2. *Dibrachys cavus* (Walker) *Pristomerus chinensis* Ashmead
3. *Aphis gossypii* (Glover)	3. *Scymnus* (*Neopullus*) *hoffmanni* Weise
4. Two-spotted spider mite	4. *Amblyseius* sp. (unpublished) Shin *et al.*

Most of the major natural enemies are described species and are identifiable. Difficult species are sent to the Academia Sinica, after being identified only to the family or subfamily level at the Shanghai Botanical Garden. They have found about 10 species of Syrphidae but have not studied their biology as yet.

We discussed four species of coccinellids as biological control agents. *Stethorus punctillum* Weise is a mite predator commonly collected in the Shanghai area. *Rodalia limbata* Motschulsky is effective against the scale *Drosichia corpulenta* Kuwanae, which attacks many plant species. *Propylaea japonica* (Thunberg) is very common in the Shanghai area and feeds on almost all aphid species.

It was asked what coccinellids are used against mites in the United States; Gordon replied that *Stethorus* spp. are used, but that there are no major published works. We promised to send literature on coccinellids that feed on mites to Mr. Lu and Ms. Xe, one of whose concerns was the two-spotted spider mite on cucurbits, cotton, and eggplants.

Helix snails and slugs are pests of cotton and wheat seedlings in the People's Republic of China.

The Chinese scientists asked if there are natural enemies of rice pests in the United States.

Knutson explained the IIBIII identification program, our interests in beneficial insects and mites of the People's Republic of China, and the taxonomic aspects of the US-PRC Agriculture Agreement. We were shown a copy of "Handbook for Plant Protection Workers," published by Shanghai People's Publishing House, 1974.

Department of Biology, Fudan University

Fudan University is the second largest university in the People's Republic of China. We visited Professor Xin Jieliu, Ph.D., (Shin Kai-Lou), and Dr. Su Teming, and received a brochure about the university.

There are nine divisions in the Department of Biology (220 teachers, including 29 at the Professor and Associate Professor levels; 140 lecturers; 120 other staff).

Zoology includes three sections: Animal Physiology, Vertebrate Zoology, and Entomology.

Entomology Section: 40 students (B.A. candidate level equivalent) and 17 staff. Two research areas: biological control of insect pests and research on insect viruses.

Insect Virology Laboratory: Dr. Su Teming and Dr. Yue Yunxien. Research has been conducted for 15 years. They worked mainly on crystalliferous bacteria for the first 10 years and have worked with *Bacillus thuringiensis* for 3 to 4 years, mainly on pests of rice and cotton, along with a little work on entomogenous fungi on aphids. Since 1974, they have worked almost exclusively on viruses. They have found 10 viruses, mainly NPV, cytoplasmic, and granulosis viruses. They have isolated 2 viruses [cytoplasmic polyhedrosis virus (CPV) and nucleopolyhedrosis virus (NPV)] from cotton bollworm (*Heliothis armigera* Huebner), which have been used in Gansu Province since 1975; they are 60 to 70 percent effective on older larvae. The NPV virus is different from the U.S. strain in that it is multiply embedded. The Chinese have also found a singly embedded NPV. However, the multiply embedded virus is the strain that is used (isolated in 1974). It is maintained on insects, not in cells.

The CPV was isolated from a lab culture and later was found in the field. Another NPV has been isolated from <u>Clania variegata</u> Snellen (a bagworm, apparently a new discovery). They have not been able to raise the host insect in the lab, so they collect hosts from the field; thus, they have only one generation per year. The laboratory has communicated with Dr. M. E. Martiglioni of the U.S. Forest Service.

This NPV has been used in Shanghai for control of tree pests since 1975. It is as effective as chemical control (60 to 70 percent). They are also working on six or seven other viruses and are now trying to develop serological procedures. Knutson inquired if there are safety regulations concerning the use of microbials in the People's Republic of China; answer: no. They have tested the NPV against silkworms - it is not susceptible. Dr. Su's opinion is that efficacy is the first consideration, and safety is the second. They have collected but not studied entomogenous fungi on aphids and rice leafhopper.

<u>Taxonomy Laboratory</u>: Two students (Mr. Ko -- phytoseids, and Miss Dong -- eriophyids) and Mme. Ding, who work on tarsonemids, especially cyclamen mites. Holotypes of new species are kept at Fudan University.

<u>Rice pests</u>: <u>Stenotarsonemus spinki</u> Smiley (widely distributed, a serious pest in Taiwan); <u>S. furcatus</u> DeLeon, <u>S. spinifex</u> (Marchal), and other, unidentified species. Dr. Xin gave us lists of Phytoseiidae and Eriophyoidea of China. Mr. Ko is studying Phytoseiidae - about 70 species in the People's Republic of China, including 20 new (unpublished) species. He is studying taxonomy and application. Miss Ding is studying Eriophyidae - histology, embryology, and life history; there are 30 species in the People's Republic of China, of which 15 are undescribed.

<u>Institute of Entomology, Academia Sinica</u>

The Shanghai Institute of Entomology was founded in 1959. There are 208 members in the institute, with laboratories for the study of insect physiology, insect toxicology, insect virology, insect taxonomy and ecology, and experimental technology. The Institute maintains a collection, with about 450,000 insect specimens, and a library with about 47,000 books.

Prof. Yang Pinglan gave us copies of "Abstracts of Publications (1959-1979)" of the institute, which listed 54 publications. We visited the collection, where Knutson spent most of the time examining the Sciomyzidae and talking with Mr. Fan Zide, a specialist on Anthomyiidae and synanthropic calyptrate Diptera.

<u>Asilidae</u> - Many specimens, especially Leptogastrinae, were identified by Xia Kailing about 1948.

<u>Syrphidae</u> - There are about 40 Schmidt boxes of unidentified specimens. Mr. Shi Dason is beginning work on the common species of Shanghai District.

<u>Sciomyzidae</u> - Five boxes of unidentified material, mainly <u>Sepedon</u>, with three specimens of <u>Dichetophora</u> sp.

Coccinellidae - About 4,000 specimens on display. These apparently have not been identified by Pang Xiongfei. The main collection is not extensively identified. The most interesting material was eight boxes of specimens from Tibet, all unidentified, which Gordon sorted to genus. This could be a significant collection if it were identified. At least 10 species of Epilachninae were included (Tibet is another area to consider for biological control studies on species of Epilachninae).

Prof. Yang said that Matsucoccus resinosae Bean & Godwin and M. matsumurae (Kuwana) are very likely the same species. He thinks M. resinosae may have been introduced into the United States at the time of the New York "World's Fair." Prof. Yang gave us specimens of all Chinese species of Matsucoccus to give to D. R. Miller (Systematic Entomology Laboratory, IIBIII, USDA, Beltsville). There are five species of Matsucoccus in the People's Republic of China, one of which is undescribed. A Chinese species has been questionably identified as M. matsumurae. It is a very destructive pest. Prof. Yang wants to have some specimens of M. resinosae and other U.S. species of Matsucoccus, and wants to borrow the type of M. matsumurae, which according to Yang is in the U.S. National Museum (USNM). He has received specimens from Dr. Takagi, Hokkaido University, Japan.

Prof. Yang stated that the following guidelines pertain to Academia Sinica (AS), Shanghai:

1. Holotypes must be preserved in the People's Republic of China.
2. Unidentified specimens can be loaned to foreign specialists if there is no Chinese expert.
3. Original descriptions must be published in Chinese journals, with complete descriptions in both languages.

Academia Sinica-Shanghai has sent taxonomists to Tibet and Lingnan Provinces to collect, but the surveys are not pest-oriented.

Academia Sinica does not take part in the nationwide survey of pests and beneficial insects and mites, but does identify some material.

HANGZHOU, MAY 27

Department of Plant Protection, Zhejiang Agricultural University

The Zhejiang Agricultural University was founded in 1910. It has 9 teaching departments and 16 "specialties," a teaching and research faculty of over 520 members, and a student enrollment of about 2000. The library has about 400,000 volumes of publications. The university has a formal agreement with Oregon State University for exchange of information and for Chinese students to study at Oregon State.

The Plant Protection Department is entirely focused on teaching and research in the area of plant protection. The Department is 52 years old and currently has 60 faculty members (11 Professors and Associate Professors, and 21 lecturers; the rest are assistants and technicians) and a total of 223 students, of which 11 are postgraduate students who work in the areas of biological control, plant pathology, chemical control, and stored product pests.

The Department has three basic research areas: entomology, plant pathology, and chemical control of pests. The entomology research area has two major areas assigned to it by the central and provincial governments. The most important area is biological control with Professors Hu Cui and Li Xuelin the principal faculty members involved. The secondary priority is integrated control, for which Professor Chu was the principal advisor until recently. In addition, Professor Tang Chinh works on sumac galls and on ant taxonomy.

We then visited the collection, which was started by Professor Chu (who died in 1980) in the 1930's. It consists mainly of parasitic Hymenoptera, with about 50,000 specimens in this category. Most of these are described species, but some are not identified. The collection has specimens from all over the People's Republic of China, but, except for the parasitic Hymenoptera, is rather small and is used only for teaching purposes. Professor Hu said that they have been planning to invite some taxonomists from the USDA to work with the collection, but nothing definite has been decided. They do not have an established policy concerning the loan or exchange of specimens, but they indicated that they would follow the policy previously explained to us.

Gordon examined the small collection of Coccinellidae (about 800 specimens) and identified most of the material to species. Almost all were common, widespread species of no particular significance to systematics, but nearly all were of some importance to biological control. Knutson was taken to the insectary, where he discussed research on sumac gall aphids with Professor Tang. The sumac gall aphid produces tannic acid, some of which is exported to the United States. The sumac is *Rhus chinensis*, and the aphid overwinters on another plant, a moss of the genus *Mnium*. There are 50 species of this moss in the People's Republic of China, but the aphid utilizes only 3 of these.

The following list of natural enemies of *Artogeia rapae* (L.) in the People's Republic of China was received from Professor Hu Cui (identifications were made by taxonomists in the Systematic Entomology Laboratory). Parasites have been studied in 20 provinces by Professor Hu for 3 years. In addition to these parasites, a granulosis virus (*Pieris brassicae* GV) has been introduced from England.

Parasites of Artogeia rapae crucivora (Boisduval)

1. *Trichogramma evanescens* Westwood
2. *T. confusum* Viggiani = *T. chilonus* Ishii
3. *Apanteles glomeratus* (L.)
4. *Apanteles rubecula* Marsh
5. *Pteromalus puparum* (L.)
6. *Brachymeria lasus* (Walker)
7. *B. femorata* (Panzer)
8. *Coccygomimus disparis* (Viereck)
9. *Exorista sorbillans* (Wiedemann)
10. *Exorista amoena* Mesnil
11. *Phryxe vulgaris* (Fallen)

Notes on the Above Species

1.	*Trichogramma evanescens*	Has a very low incidence of parasitism.
3.	*Apanteles glomeratus*	Has a low incidence of parasitism due to chemical control.
4.	*Apanteles rubecula*	Was introduced from Canada via H. C. Chiang, University of Minnesota. Difficult to rear because there are so many viruses. Same species was found in North and Northeast China 2 years ago. This has been proved by cross-mating tests. Parasitism by this species is higher in North than in South China.
5.	*Pteromalus puparum*	Common on pupae in South China. Work is being emphasized on this species. Augmentation has increased levels of parasitism by 20 to 60 percent.
9-11.	Tachinidae	Are more common in North and Northeast China.

Professors Li Zueliu and Pan Mensziang gave us the following list of the hymenopterous parasites of the white peach scale in the Hangzhou area:

Aphelinidae

1. *Prospaltella berlesei* (How.) (common)
2. *Aphytis proclia* (Wlk.) (Prof. Li has shown this species to Dr. P. DeBach)
3. *Marietta* sp.
4. *Archenomus* sp.

Encyrtidae

5. *Apterencyrtus microphagus* (Mayr)
6. *Thomsonisca typica* (Mercet)
7. *Adelencyrtus aulacaspidis* (Brethes)
8. *Arrhenophagus chionaspidis* Aurivillius

Mr. Pan (Prof. Li's graduate student) is studying parasites of scales on mulberry. White peach scale is distributed in Central and East China and is a serious pest of tea and fruit trees in this area. San Jose scale is distributed primarily in North China. Very few parasites have been found on it in the Hangzhou area.

A 2-month short course in biological control and taxonomy was given in 1980, once in Hangzhou and once at Beijing Agricultural University. About 60 students were involved. The course was funded by the Ministry of Agriculture. The syllabus for the "Parasitic Hymenoptera Training Course", sponsored by the Maryland Center for Systematic Entomology, is being provided to Prof. Hu for translation into Chinese. Prof. Hu will be a visiting professor in the Department of Entomology, University of Maryland, for about 1 year, beginning in October or November 1982.

Forestry Institute, Zhejiang Province

Located about a half hour, by car, from the city.

	Scientist	Research Area
1.	Mr. Zhou Chongguang	Professor, Leader of the Institute
2.	Mr. Sun Yanxi	Management of scientific research
3.	Ms. Fang Huilan	Deputy Chief of Laboratory, forestry protection
4.	Mr. Hu Huelin	Studies on *Matsucoccus* control
5.	Ms. Yang Mudan	Studies on *Matsucoccus* control
6.	Mr. Cai Ximing	Studies on *Dendrolimus*
7.	Ms. Lian Yueyan	Studies on control of Chinese-tallow tree pests

Mr. Zhou then gave us a brief account of the institute, which was established in 1958 and currently has a staff of 120 people. There are eight laboratories in this Institute: Used Timber, Economic Trees, Forest Protection, Bamboo, Physiology and Biochemistry, Forest Chemistry, Forest Mechanisms, and Soil Analysis. They also have several experimental farms. The leader of the Forest Protection Laboratory, Mr. Hu Huelin, gave us information on the research conducted in that laboratory. From 1972 to 1975, they studied biological control of the pine caterpillar (*Dendrolimus punctatus* (Walker)), using *Trichogramma* sp. and a fungus, *Beauveria bassiana*, as control agents. From 1975 to the present, they have been studying the natural enemies of the scale, *Matsucoccus matsumurai*, which is a serious pest of pine trees.

The most important natural enemy and the only one on which they are conducting research is a native Chinese coccinellid, *Ballia obscurosignata*. Mr. Hu Huelin gave us reprints of a publication on this research and explained some of the pertinent details. *Ballia obscurosignata* has 4 generations per year in the Hangzhou area, the adults become active in early March, lay eggs in late March, and the first generation occurs from March to early July. The second generation occurs from June to August, the third generation from July to mid October, and the fourth generation from late September to June. The shortest generation time observed was 15 days; the longest, 51 days. The second generation takes 20 to 25 days at 23° C, the third generation takes 15 to 26 days at 28° C, and the fourth generation takes 23 to 48 days at 20° C.

Adults of *Ballia* begin mating 10 days after emergence and begin egg laying 7 days later, with an average of 400 eggs per female. The maximum number of eggs observed was 900 from a single female. The eggs are laid on pine needles in the shade. *Ballia* will feed on aphids as well as on *Matsucoccus* when the latter is in short supply. The larval and adult feeding habits are similar, with the fourth-instar larva the most voracious stage, consuming 40 to 50 percent of the total food taken by this species. One *Ballia* larva can consume 13 scales per day; an adult can consume 4.3 scales per day. *Matsucoccus* has two generations per year. Nymphs appear in early March and again from August to November. In the intervening months, the nymphs are difficult to find, so *Ballia* is forced to prey on the adult stage.

The life cycles of prey and predator are well synchronized to the benefit of the predator. The Forest Protection Laboratory rears *Ballia* and releases eggs and larvae twice a year in the problem areas. The artificial diet consists of honey bee larvae, which are placed, one each, in a vial with one

coccinellid larva. One change of food is required to rear the coccinellid through to the adult, and 70 percent survival is normal. The eggs are obtained by caging one male with five females in a small glass container along with pine needles on which the females lay eggs. Release is accomplished by tying small paper containers of eggs and larvae to pine trees, one per tree in areas of heavy scale infestation, less where the scale is less frequent. Complete and continuous control is not accomplished by this method, and new releases of *Ballia* must be made each year to maintain satisfactory control of the scale. In addition to rearing *Ballia* in the laboratory, they are also experimenting with raising the coccinellids *Chilocorus rubidus* Hope, *Chilocorus kuwanae* Silvestri, and *Exochomus mongol* on an artificial diet of honey bee larvae and raw fish, mixed 1:1.

The afternoon was completed with a short question and answer session. We were asked about biological control of *Matsucoccus resinosae* in the United States. We explained that biological control methods are not yet being used and mentioned the possible synonymy of *M. resinosae* and *M. matsumurai*.

Knutson asked if sawflies were a forest pest there and they replied that they were not. They asked about gypsy moth control in the United States. Knutson gave a sketch of the history of U.S. biological control efforts and discussed the prognosis for future biological control research on gypsy moth. We were told that the gypsy moth occurs in North China and that biological control research is concentrated in the northeastern provinces.

In the afternoon we presented a seminar on IIBIII and our personal research to about 35 people from Zhejiang Agricultural University, the Forestry Institute, the Academy of Agricultural Sciences of Zhejiang Province, the Zhejiang Museum, the Citrus Research Institute of Huangyan County, and the Agricultural Research Institute of Kunghua District. Knutson discussed the activities of the Institute Office and the Beneficial Insect Introduction Laboratory, IIBIII, as well as his research on Sciomyzidae. Gordon discussed the responsibilities of the Systematic Entomology Laboratory, IIBIII, and his research on Scarabaeidae (*Aphodius*). A short question and answer session followed. Gordon answered questions concerning Coccinellidae involved in control of citrus pests and miscellaneous questions regarding Coccinellidae. Knutson responded to questions regarding Sciomyzidae and their potential as biological control agents of snails.

HANGZHOU, MAY 28

Zhejiang Provincial Museum

We were greeted by Mr. Zhou Wenbao and Cai Chunmo, who gave us some information on the Museum and the insect collections. The Museum was established in 1929, and the collection is a part of the Bureau of Entomology, Zhejiang Province. The collection has about 10,000 specimens, primarily Lepidoptera and Odonata (100 species). Most of the insect collection dates from 1945 because of the destruction that occurred during the Sino-Japanese War. There are two entomologists on the Museum staff. The Museum consists of two sections: History of Civilization in Zhejiang Province and Natural History. The Museum functions mainly for popular education of the people, particularly students. Chinese taxonomists have not studied this collection, at least not recently. We were told that most provinces have a small museum

of this type and that the largest insect collections in provincial museums are in Tianjin (Hemiptera - specialist is Liu Shenli) and Heilonjiang. Also, there is a large insect collection at the Department of Biology, Nanchang University. The provincial museums are of three major types under three administrative areas: Ministry of Culture, Science Committee, and Art Object Management Committee.

Knutson described the Association of Systematics Collections (ASC), and they said they wished to be put on the mailing list. The subject of collecting and research by foreign scientists in the People's Republic of China was brought up, and they said that permission must be received from Dr. Zhu of the Zoological Institute, Beijing, because the provincial museums are officially connected with that Institute. Knutson asked if it would be possible for one museum or university to borrow all specimens of a particular insect group from other Chinese collections if a foreign scientist needed to study them. The answer was yes, this could be done.

Professor Hu asked about the areas of taxonomic interest of the scientists we were considering sending to the People's Republic of China. We responded these would probably be Coccidae and Syrphidae.

We then visited the insect collection. Mr. Zhou has published at least one paper on Odonata and is now interested in beetles (Cerambycidae). He cooperates with Dr. Chiang, who is President of the Nanchang University and a specialist in the Cerambycidae.

GUANGZHOU, MAY 29

Entomology Research Institute, Academia Sinica, Guangdong Province

We were met by Dr. Li Liying (Deputy Director) and her husband, Dr. Pang Xiongfei. Dr. Li introduced us to the following staff members who were present:

	Scientist	Research Area
1.	Li Liying	Deputy Director
2.	Huang Mingdu	Associated scientist
3.	Zeng Hue	Assistant scientist
4.	Chuang Zhiching	Assistant scientist
5.	Wu Weinan	Assistant scientist
6.	Du Weishan	Staff member of the Foreign Affairs Group
7.	Yang Piao	Staff member of the Foreign Affairs Group
8.	Pang Xiongfei	Professor, Agricultural College of South China

Dr. Li also explained the various research projects that have been studied in this laboratory:

1. A stinkbug (*Tessarotoma papillosa* (Drury)) is the main pest of lichee, and they have been using a species of *Anastatus* for biological control since 1961. There is only one generation of the stinkbug each year, so the parasite is quite successful; no insecticides are used any more. The parasite is mass reared on eggs of the Eri silkworm, one per egg. The *Anastatus* has a

November-to-March diapause; therefore, the mass release takes place in the fall for spring emergence. About 600 Anastatus per lichee tree are released, with the usual result being 95 percent parasitism of the stinkbug. An insecticide, Dipterex, was tried at one time, but it kills honey bees. Lichee honey is considered a delicacy; therefore, Dipterex was unacceptable.

2. Prior to 1970, the coccinellid, *Cryptolaemus montrouzieri*, was introduced for mealybug control on citrus and cacao. A search was made for this coccinellid in 1974 and 1975, with negative results. In 1979, it was recovered and is now firmly established in the Guangzhou area on a species of tree (*Aleurites moluccana*).

3. In 1964 the Cuban fly was introduced to control stem borers of rice. The fly was released three times but was not established. In 1980 this fly was again released in Guangdong Province, with assistance from E. G. King, Jr. (SEA/ARS/USDA, Stoneville, MS). The results are still unknown.

4. From 1971 to the present, research has been conducted on the use of *Trichogramma* wasps against various pests. *Trichogramma confusum* (= *T. chilonus*), *T. dendrolimi* Matsumura, and *T. japonicum* Ashmead are the species commonly utilized. In 1979, a U. S. species, *T. pretiosum* Riley, and *T. cacoeciae* Marchal from West Germany were introduced for use against sugarcane stem borers. This work has just begun and the results are unknown.

5. In 1975, work was begun with *Amblyseius newsami* (a pesticide-resistant predaceous mite) against citrus red mite (*Panonychus citri* (McGregor)), in Guangdong Province. This species has been released on 200 hectares of citrus orchards and is apparently quite effective. Dr. Wu works on the taxonomy of *Amblyseius* at Fudan University, Shanghai, in cooperation with Dr. Shin. Other species of predaceous mites in the genera *Typhlodromus* and *Phytoselius* from Australia that are also resistant to organophosphate chemicals have been brought into the People's Republic of China, but because they are effective only against mites on apple these were sent to the Biological Control Laboratory, Beijing.

6. Studies on Australian nematodes, genus *Neoplectana*, were begun in 1979. Ten species are being studied. Insects attacked are sugarcane borers and beetles, termites, and mosquitos. Australian (CSIRO) scientists will go to Guangzhou in 1982 to work with these nematodes.

7. The institute also conducts some research on other natural enemies of pests on pine, rice, and citrus.

Dr. Huang presented a talk, with slides, on his research on *Amblyseius newsami* for control of the citrus red mite. He discussed the use of a "green manure" crop (*Ageratum conyzoides*), which is planted in citrus orchards for two reasons: (a) the mites feed and survive on the *Ageratum* pollen, and (b) the lush vegetation reduces the air temperature of the orchard an average of 5° and increases humidity.

The latter point is very important becaus A. newsami does well under conditions of high humidity and lower air temperatures but it is not effective under reverse conditions. Air temperature at the leaf surface in orchards without green manure may reach 40° C. This is an excellent example of environmental modification procedures that appear to be well understood by Chinese biological control scientists. The peak populations of A. newsami are in June and October; lowest populations are in July and August. In addition to Ageratum, tea, castor bean, and melons have been used as green manure crops. Castor bean pollen gives the best laboratory results as a diet for rearing A. newsami. Dr. Tanaka has introduced A. newsami into Japan.

We were shown a film on the natural enemies of rice pests in the People's Republic of China. Pests treated in this film were: grasshoppers, Hesperiidae spp. leaf rollers, stem borers, rice gall midge, leafhoppers, and aphids. Natural enemies discussed were: nematodes of planthoppers, Apanteles sp., Trichogramma sp., Brachymeria sp., Platygaster oryzae Cameron, spiders (about 120 species are used in Hunan Province; the eggs are collected from the early crop and put on later crops), Staphylinidae, Coccinellidae, Carabidae, ants, and frogs. An interesting bit of information in the film was the use of a remote-controlled model airplane to distribute packets of Trichogramma in rice fields.

We were also shown a film (1976) on Anastatus sp. for biological control of the lichee stinkbug. This information is included under the preceding stinkbug discussion.

Dr. Pang Xiongfei and Dr. Gordon discussed the taxonomy of the Coccinellidae. Dr. Pang gave us copies of all of his publications on coccinellids, as well as a list of the Chinese species of Epilachninae (plant-feeding Coccinellidae) and a list of the scale-feeding Coccinellidae in the People's Republic of China. He stated that he has observed at least three species of Hymenoptera serving as parasites of species of Epilachninae.

South China Agricultural College

The South China Agricultural College was established in 1952 as a result of the reorganization of the agricultural colleges of Zhongshan University and Lingnan University. It has 8 departments and 15 specialties, 700 teachers, and 2,000 students.

We visited Dr. Pang's laboratory, located outside of Guangzhou. We were greeted by Mr. Lu Jixiang, Deputy Chief of the Dean's office, and met the following entomologists of the college:

	Scientist	Research Area
1.	Mr. Chen Shoujian	Biological control of citrus insects and taxonomy of Carabidae
2.	Mr. Zhang Waichou	Agricultural entomology - thrips
3.	Mr. Lu Jixiang	Deputy Chief of Dean's Office
4.	Dr. Pang Xiongfei	Biosystematics of Trichogramma, Coccinellidae

Scientist	Research Area
5. Prof. (Ms.) Liu Siuking	Microlepidoptera and citrus insects, Head of Department of Plant Protection. Teaching and research on agricultural entomology
6. Prof. Wu Yongzhong	Taxonomy of Noctuidae

The insect collections at this college consist of about 26 cabinets (15 drawers each, about 80,000 specimens). The Coccinellidae collection consists of 10 drawers (1500 specimens); the bulk of the specimens examined and identified by Dr. Pang have been sent to the Zoological Institute in Beijing. Pang and Gordon discussed the possibility of collaborating on the taxonomy of the Scymninae (Coccinellidae) of the People's Republic of China and a tentative agreement was reached to exchange identified specimens of North American and Chinese species of Coccinellidae. Zhongshan University in Guangzhou has a collection of about 200,000 specimens.

In addition to her principal interests, Professor Liu is also interested in Phyllocnistidae, leaf miners of citrus and other fruit trees. She is working on the genus Phyllocnista in the People's Republic of China, which consists of 50 described species and about 20 new species. Mr. Zhang said that there are about 120 species of thrips in South China and that he has been working on thrips research for 7 years.

We asked about the structure of the Chinese Society of Entomology. The main office is in Beijing with major branches in Shanghai and Guangzhou. There is some activity in most of the provinces. We asked whether there are any amateur entomologists in the People's Republic of China; they replied that there are none to the best of their knowledge.

We were given two containers of living Amblyseius newsami to be delivered to the Beneficial Insects Research Laboratory, USDA, Newark, Delaware.

BEIJING, JUNE 1

In the afternoon we met with Dr. Qui Shibang at our hotel and discussed many of the basic questions pursued throughout our visit. He agreed with the responses we had already received regarding loan of specimens, borrowing of specimens, etc., and we further discussed the need for a coordinator to be appointed to handle matters such as collecting and loaning specimens where United States-Chinese cooperation is necessary.

DIRECTORY OF SYSTEMATIC ENTOMOLOGISTS IN THE PEOPLE'S REPUBLIC OF CHINA

This directory lists 151 persons who are conducting or who have recently conducted taxonomic studies at 45 institutions in the People's Republic of China. The directory is derived from lists prepared by J. R. Coulson and D. R. Davis during their visits to China in 1979 and 1980, from information supplied by P. M. Marsh and E. E. Grissell from their 1980 visit, from articles published in "Entomotaxonomia" and "Acta Entomologica Sinica" (source indicated in parentheses after name of taxonomist), with additions and corrections obtained during the 1981 visit by L. Knutson and R. D. Gordon. Visits to laboratories are shown in parentheses below the name of the pertinent laboratory. The names in this directory were reviewed and corrected by A. C. F. Hung, Beneficial Insect Introduction Laboratory, IIBIII. I thank Mr. William L. Davis, formerly Agricultural Counselor, Beijing, for helpful comments on the formation of names. Prof. Yang Pinglan, Director, Institute of Entomology, Academia Sinica, Shanghai, provided many important corrections and additions.

Since 1949, formal titles and an hierarchical ranking system have generally not been used in universities, colleges, and scientific laboratories in the People's Republic of China (PRC). Exceptions to this are persons who have received a Ph.D. degree in an overseas university, and in some cases, persons who received a Ph.D. degree in China prior to 1949. Most Chinese scientists address each other as "Comrade," or when speaking English, use "Mr." or "Professor." Most units apparently do have a "Chairman," "Director," or at least someone who functions in that role, although they may not be officially titled as such. Descriptions of staff are frequently given as "X number of people at the assistant professor level," "X at the associate professor level," etc.

The titles "Mr." and "Miss" are appropriate, but "Mrs." or "Madame" is not an appropriate title for a married woman (except when using her husband's surname), because married women use their own family name. In written correspondence, the title "Ms." may be most appropriate, although this term does not seem to be familiar in China.

In the following directory, the modern (pinyin) transliteration of names is given first, followed by the old spelling (Wade-Giles). In a few instances, the spelling is that used by the scientist, particularly for persons who have published under the old transliteration. In the Chinese system, the family name is first and the given name is second. In the past few years, the hyphen in the given name has been dropped and the given name consists of one word. The pinyin system is used for place names herein. Names or parts of names that are questionably spelled are underlined. Names preceded by a question mark and in brackets, are neither pinyin or Wade-Giles and cannot be corrected without the Chinese characters. Non-taxonomic interests are included at the end of entries.

Please send corrections and additions to this directory to Lloyd Knutson, Chairman, Insect Identification and Beneficial Insect Introduction Institute, Rm. 1, Bldg. 003, Beltsville Agricultural Research Center - W, Beltsville, MD 20705.

L. Knutson, Oct. 15, 1981

Institute of Zoology, Department of Insect Taxonomy and Faunology, Academia Sinica, BEIJING
(Coulson-79, Davis-79, Grissell & Marsh-80, Knutson & Gordon-81)

Prof. Dr. Cai Banghua (Tsai Panghwa) [Vice Director] -- Isoptera. Hymenoptera: Scolytoidea.

Prof. Dr. Zhu Hongfu (Chu Hung-fu) [Deputy Director] -- Lepidoptera: Geometridae, Sphingidae, Saturniidae, Bombycidae, Drepanidae, Hepialidae, Brahmaeidae, Uraniidae, Pterothysanidae, Callidulidae, Endromidae, Episopeiidae. Homoptera: Aphidoidea.

Prof. Dr. Zhao Yangchang (Chao Yung-chang) [Vice Director] -- Coleoptera: Curculionoidea, Dermestidae. (Deceased)

Mr. Zhao Jianming (Chao Chien-ming) [Vice Director, Associate Research Scientist] -- Diptera: Tachinidae, Sarcophagidae.

Mr. Meng Xianling (Meng Hsiang-Ling) - Director for Research, Administrative Section, Institute of Zoology.

Coleoptera

Prof. Dr. Chen Shixiang (Chen Secien or (Chen S.H.) [Director] -- Chrysomelidae.

Ms. T'an Chuanchieh [Tan Zhuanjie] [Associate Research Scientist] -- Meloidae, Cicindelidae, Eumolpidae, Fossil insects.

Ms. Yu Peiya [Associate Research Scientist] -- Carabidae, Crioceridae.

Ms. Pu Fuji (Pu F. J.) [Assistant Research Scientist] -- Cerambycidae.

Mr. Chang Youwei [Assistant Research Scientist] -- Scarabaeoidea.

Mr. Li Hongxing (Lee Hung-shing) [Assistant Research Scientist] -- Bruchidae, Curculionidae.

Ms. Chen Yuanquing [Research Assistant] -- Curculionoidea.

Mr. Huang Fusheng [Associate Research Scientist] -- Scolytidae. Protura. Zoraptera.

Ms. Yin Hweifeng [Associate Research Scientist] -- Scolytidae, Platypodidae.

Lepidoptera

Prof. Lee Chuanlung (?Li Zhuanlong) -- Rhopalocera, Papilionidae.

Mr. Wang Pingyuan [Associate Research Scientist] -- Pyralidae, Zygaenidae.

Mr. Liu Yujiao (Liu Yu Chiao) [Associate Research Scientist] -- Tortricidae, Cochylidae, Ethmiidae.

Mr. Chen Yixin [Assistant Research Scientist] -- Noctuidae, Agaristidae, Cossidae.

Ms. Fang Chenglai [Assistant Research Scientist] -- Arctiidae, Amatidae, Hypsidae.

Mr. Cai Rongquan [Assistant Research Scientist] -- Notodontidae, Limacodidae.

Ms. Chao Chungling [Assistant Research Scientist] -- Lymantridae, Psychidae, Thyatridae.

Mr. Hou Tauchien [Assistant Research Scientist] -- Lasiocampidae, Thaumetopoeidae. Coleoptera: Buprestidae.

Hymenoptera

Mr. Liao Ding-shi (Liao Tingshi) [Associate Research Scientist] -- Chalcidoidea.

Mr. Chen Tailu -- *Trichogramma*.

Ms. Wu Yanru (Wu Yenju) [Associate Research Scientist] -- Apoidea, Proctotrupoidea.

Ms. Wang Sufang [Assistant Research Scientist] -- *Bombus*, Ichneumonidae.

Ms. Wang Kingyen [Research Assistant] -- Braconidae.

Diptera

Mr. Lee Tiesheng (Li Tiesheng) [Assistant Research Scientist] -- Ceratopogonidae. Hymenoptera: Vespoidea.

Ms. Shi Yongshan [Assistant Research Scientist] -- Tachinidae, Syrphidae. (works with Dr. Chao)

Ms. Sun T.H. [Assistant Research Scientist] -- Syrphidae, Anthomyiidae, Calliphoridae, Muscidae.

Ms. Ma Sufang [Assistant Research Scientist] -- Culicidae.

Ms. Wang Zunming (Mrs. Li Tie-Sheng) [Research Assistant] -- Tabanidae. (Recently at Oregon State University).

Homoptera

Mr. Zhang Guangxue (Chang Guangshyue) [Associate Research Scientist] -- Aphidoidea. Thysanoptera.

Mr. Wang Tzeching [Assistant Research Scientist] -- Coccoidea.

Zhong Tiesen -- Aphidoidea (Entomotaxonomia).

Ticks-Lice-Mites

Mr. Teng Kuofan [Associate Research Scientist] -- Ixodoidea, Gamasoidea Anoplura.

Ms. Wang Huifu [Assistant Research Scientist] -- Acarina: Tetranychidae.

Museum of Natural History, BEIJING
(Davis-79)

Mr. Liu Szenang -- General Entomology.

Ms. Wang Shechan -- General Entomology.
Both are involved mainly in exhibit work at present (no publications).

Department of Plant Protection,
Beijing Agricultural University, BEIJING
(Coulson-79)

Mr. Yang Ji-kun (Yang Chi-kun) -- Neuroptera: Chrysopidae and other beneficial insects. Diptera: Rhagionidae.

Forest Research Institute, Chinese Academy of Forestry, BEIJING
(Knutson & Gordon-81)

Prof. Xiao Gangrou (Hsiao Kang-Jou) [Vice Director] -- Hymenoptera: Tenthredinoidea.

Dr. Huang Xiaoyun -- Hymenoptera: Tenthredinoidea (contact of D.R. Smith).

Dr. Zhou Shushi -- Hymenoptera: Tenthredinoidea (contact of D.R. Smith).

Mr. Li Guan-wu -- Hymenoptera: Tenthredinoidea (contact of D.R. Smith).

Institute For Microbiology and Epidemiology, Chinese Academy of Medical Sciences, P.O. Box 130, BEIJING

Mr. Yu Yixin -- Diptera: Ceratopogonidae (contact of W.W. Wirth).

Prof. Luh Paoling -- Diptera: Culicidae.

Ji Shuli -- Siphonaptera (Entomotaxonomia).

Ren Shiming -- Siphonaptera (Entomotaxonomia).

Dou Guilan -- Siphonaptera (Entomotaxonomia).

Tianjin (Tientsin) Museum of Natural History, TIANJIN, HEBEI PROV.

Liu Shenli (Sheng-li) -- Hemiptera: Acanthosomatidae (Entomotaxonomia).

Department Biology, Nankai University, TIANJIN, HEBEI PROV.

Mr. Zheng Leyi (Zheng Le-yi) -- Hemiptera: Lygaeidae (Entomotaxonomia).

Tianjin Animal and Plant Quarantine Service, Pu-Cow Road, TIANJIN, HEBEI PROV.

Guan, Liang-Hua -- Taxonomy of stored-product pests, especially Coleoptera, and quarantine.

Laboratory of Taxonomy and Ecology, Shanghai Institute of Entomology, Academia Sinica,
Chungkin Road (S.), 225 SHANGHAI
(Coulson-79, Davis-79, Grissell & Marsh-80, Knutson & Gordon-81)

Prof. Xia Kailing (Hsia Kai-ling) [Laboratory Head] -- Orthoptera: Acridoidea. Isoptera. (Asilidae).

Protura

Prof. Ms. Yin Wenying (Yin Wen-Ying) [Vice Director]

Mr. Zhang Zhi-yang

Isoptera

Mr. Fan Shude (Fan Shu-teh)

Ms. Han Meizhen

He Xiu-song

Orthoptera

Ms. Bi Daoying -- Acridoidea.

Ms. Jin Xingbao -- Acridoidea.

Homoptera

Prof. Yang Pinglan (Young Bainley) - [Director of the Institute] -- Coccoidea, Aleyrodidae.

Mr. Hu Jinglin (Hu Jin-lin) -- Coccoidea.

Diptera

Prof. Fan Zide (Fan Tze-teh) -- Anthomyiidae, Muscidae, Calliphoridae (especially synanthropic calyptrate Diptera), Hypodermatidae, Syrphidae, Sarcophagidae (not including Tachinidae).

Mr. Chen Zhizi (Chen Tzi-Tze) [Assistant] - Engineer -- Sarcophagidae.

Prof. Liu Weide (Liu Wi-teh) [Vice Director] -- Tabanidae, Culicidae.

Lepidoptera

Mr. Li Chengzhang (Li Cheng-chang) -- Pyralidae.

Hymenoptera

Mr. Shi Dasan [Deputy Head of the Laboratory] -- Hymenoptera: Trichogramma, Aphidiidae. Diptera: Syrphidae.

Acarina

Mr. Wang Xiaozu (Wang Shio-tsu) -- Acaridae, Cheyletidae, Glycyphagidae.

Hemiptera

Ms. Jin Qinying

Dept. Biology, Fudan University, SHANGHAI
(Knutson & Gordon-81)

Acarina

Prof. Xin Jie-lou (Shin Kai-lou) -- especially Trombidiidae.

Mr. Liang Lai-rong -- Phytoseiidae.

Mrs. Ke Li-sheng -- Phytoseiidae.

Ms. Ding Ting-zhong -- Tarsonemidae (cyclamen mites), Eriophyidae.

Ms. Dong Hui-qing -- Eriophyidae.

Museum of Natural History, SHANGHAI, SHANGHAI PROV.
(Davis-79)

Ms. Yuan Ilan -- Acarina.

Shanghai College of Agriculture, SHANGHAI

Mr. Ma, En-Pei -- Acarina: Tetranychidae (Acta Entomologica Sinica).

Shanghai First Medical College, SHANGHAI

Prof. Wen, Ting-Huan -- Acari (Acta Entomologica Sinica).

Second Military Medical College, Dept. of Parasitology, SHANGHAI
(Davis-79)

Prof. Xu Feng-yi (Chu Fengi) -- Diptera: Culicidae, Ceratopogonidae.

Zhongshan (= Chung San University or Sun Yat Sen University), Dept. of Biology, Entomology Research Institute, GUANGZHOU, GUANDONG PROV.
(Coulson-79, Davis-79)

Prof. Pu Zhelong (Pu Chih-Lung) [Dept. Chief] -- Coleoptera: Hydrophilidae and other aquatic Coleoptera.

Hua Lichung [?Lizhong] -- Coleoptera: Cerambycidae.

Chen Chunyao -- Hemiptera: Scutelleridae, Pentatomidae.

Prof. Gjoan Yuwein (Djou Yu-wen) -- Hymenoptera: parasites of scale insects.

Guangdong Entomological Institute, Insect Taxonomy Division, Academia Sinica, GUANGZHOU, GUANDONG PROV.
(Coulson-79, Davis-79)

Ms. Li Liying (Mrs. Pang Xiongfei) [Director] -- Hymenoptera: Trichogrammatidae.

Mr. Lin Ping [Vice Director] -- Coleoptera: Scarabaeidae (Rutellinae).

Mr. Li Gui Xiang -- Isoptera.

Mr. Li Yan _Chyuan_ [Curator of Collection] -- General Classification.

Mr. Ren Hui [Research Assistant - student] -- Hymenoptera: Chalcidoidea, esp. Chalcididae.

Mr. Wu -- Acarina: Phytoseiidae (_Amblyseius_).
Lin Shanxiang -- Collembola.

Department of Plant Protection; South China Agricultural College
GUANGZHOU, GUANDONG PROV.
(Coulson-79, Knutson & Gordon-81)

Prof. Pang Xiongfei (Pang Hsui-fei) [Deputy Director] -- Coleoptera: Coccinellidae. Hymenoptera: Trichogrammatidae.

Chen Shoujian -- Coleoptera: Carabidae (biological control of citrus insects).

Ms. Liu -- Lepidoptera: Phyllocnistidae (_Phyllocnista_).

Mr. Zhang Waichu (Chang Wai-chu) -- Thysanoptera.

Fujian Agricultural College, SHAXIAN, FUJIAN PROV.

Dr. Zhao Xiufu (Chao Hsiu-fu) -- Hymenoptera: Ichneumonoidea (biological control of rice insects). (Ph.D. - Univ. Massachusetts).

Chen Jiahua -- Hymenoptera: Aphidiidae (biological control of vegetable insects).

Huang Bangkan -- Coleoptera: Coccinellidae (biological control of fruit insects).

Zhejiang Agricultural University, Department of Plant Protection,
HANGZHOU, ZHEJIANG PROV.
(Coulson-79, Knutson & Gordon-81)

Mr. He Junhua (He Chuen-hua) -- Hymenoptera: Ichneumonoidea, Braconidae (biological control of rice insects).

Prof. Li Xueliu (Lee H. L.) -- Hymenoptera: Chalcidoidea: Encyrtidae, Aphelinidae (biological control of citrus insects).

Prof. Zhu Ruzuo -- deceased (1980).

Prof. Tang-Jiao -- Hymenoptera: Formicidae.

Zhejian Provincial Museum, HANGZHOU, ZHEJIANG PROV.

Mr. Zhou Wenbao -- Odonata. Coleoptera: Cerambycidae.

Mr. Cai Chanmo --

Shenyang Agricultural College, SHENYANG, LIAONING PROV.
(Coulson-79)

Zhang Jing -- Taxonomy and use of Trichogramma.

Southwestern Agricultural College, CHONGQING, SICHUAN PROV.
(Coulson-79)

Prof. Jiang (or Qiang) Shunan (Chiang Shunan) (President of the College) -- Coleoptera: Cerambycidae.

Prof. Li Longshu -- Acarina.

Citrus Research Institute, CHONGQING, SICHUAN PROV.

Yu Zhiren -- Acarina: Phytoseiidae (studying at Univ. Calif., Riverside, beginning August 1981).

Department of Parasitology, Chongqing (=Chungking) Medical College, SICHUAN PROV.

Jeu, Ming-Haw -- Diptera: Ceratopogonidae.

Rong, Yun-Long -- Diptera: Ceratopogonidae.

Sichuan Institute of Agriculture, CHENGDU, SICHUAN PROV.
(Davis-79)

Prof. Chen Fangyi -- Homoptera: Coccidae (Institute Director).

Mr. Jiang Guang-Zao -- Homoptera: Coccidae.

Division of Medical Zoology and Entomology,
Health & Anti-epidemic Station of Sichuan, SICHUAN PROV.

Chen, Ning-Yu -- Siphonaptera (Acta Entomologica Sinica).

Wei, Shu-Feng -- Siphonaptera (Acta Entomologica Sinica).

Quinghai Province (West) Institute of Biology, XINING, QINGHAI PROV.

Su Tizhi -- Acarina.

Beng Guiying -- Acarina.

Chen Xiudao -- Acarina.

Institute of Forestry, Qinghai (=Chinghai) Academy of Agriculture & Forestry, QINGHAI PROV.

Hsu, Chen-Kuo (Xu Chen-Kuo) -- Lepidoptera: Lasiocampidae.

Department of Biology, Shaanxi (Shensi) Normal University, SHAANXI PROV.

Zheng, Zhe-Min -- Orthoptera: Acrididae.

Academy of Agricultural Sciences, WUKUNG, SHAANXI PROV.

Huo Shaotung -- Hymenoptera: biotypes of *Trichogramma*.

Department of Plant Protection, Northwestern College of Agriculture, WUKUNG, SHAANXI PROV.
(Knutson & Gordon-81)

Prof. Dr. Zhou Yao (Chou Io) -- Homoptera: Membracidae, Fulgoridae, Cercopidae. Coccoidea: Diaspididae. Apterygota. Mecoptera. Lepidoptera: Plusiinae, Noctuidae.

Prof. Lu Jinsheng -- Hemiptera: Nabidae.

Mr. Yuan Feng [Lecturer] -- Homoptera: Membracidae.

Mr. Chen Tong [Assistant] -- Apterygota.

Mr. Wei Jianhua [Lecturer] -- Coleoptera: Coccinellidae.

Ms. Lu Zheng (Lu Tseng) (Mrs. Chou Io) -- Homoptera: Cercopidae. Acarina. Lepidoptera: Noctuidae.

Mr. Liu Shaoyou -- [Lecturer] -- Syrphidae (Syrphus and Sphaerophoria).
Ran Ruibi [Lecturer] -- Neuroptera: Chrysopidae.

North West Plateau Institute of Biology, Academia Sinica

Yin Xiangchu -- Orthoptera: Acrididae.

Jiangxi (=Kiangsi) Communist Labour University, JIANGXI PROV.

Prof. Chang, Shi-Mei -- Hemiptera: Pentatomidae (Acta Entomologica Sinica).
Jin, I-Shou -- Hemiptera: Pentatomidae (Acta Entomologica Sinica).

Jiangxi University, Department of Biology, NANCHANG, JIANGXI PROV.

Dr. Chu Chimin -- Acarina: Phytoseiidae (contact of Tokuwo Kono and E. W. Baker).

Dr. Jiang (Chiang) (President of the University) -- Coleoptera: Cerambycidae.

Institute of Agriculture, NANTUNG, JIANGSU PROV.

You, Qi-Ti -- Hymenoptera: Ichneumonidae (Acta Entomologica Sinica).

You, Shi-Jin -- Hymenoptera: Ichneumonidae (Acta Entomologica Sinica).

Guiyang (Kweiyang) Medical College, GUIZHOU PROV.

Prof. Jin Daxiong (Chin Ta-hsiung) -- Anoplura: Enderleinellidae (Entomotaxonomia).

Prof. Li Guizhen (Li Kuei-chen) -- Siphonaptera (Entomotaxonomia).

Chen Han-bin -- Diptera: Culicidae (Acta Entomologica Sinica).

Division of Forest Protection, Yunnan Forestry Institute, Hot Springs, KUNMING, YUNNAN PROV.

Wu Yi -- Hymenoptera (Diprionidae).

Kunming Institute of Zoology, Academia Sinica, KUNMING, YUNNAN PROV.
(Davis-79)

Mr. Gan Yunxing [Head of Division of Taxonomy] -- Diptera: Calliphoridae. Lepidoptera: Noctuidae.

Mr. Chao Wanyuan -- Homoptera: Aphididae.

Mr. Kiong Tiang -- Hemiptera: Coreidae.

Health and Epidemic Station of Jianchuan, YUNNAN PROV.

Yang, Xue-Shi -- Siphonaptera (Acta Entomologica Sinica).

Control and Research Institute of Epidemic Diseases of Yunnan, YUNNAN PROV.

Hu Gui -- Siphonaptera (Entomotaxonomia).

Gong Zhenda -- Siphonaptera: Hystrichopsyllidae (Entomotaxonomia).

Xie Pao-Ji (Hsieh, Pao-Chi) -- Siphonaptera: Hystrichopsyllidae (Acta Entomologica Sinica).

Yang, Guang-Rong -- Acari (Acta Entomologica Sinica).

Yu, Shi-Jin -- Acari (Acta Entomologica Sinica).

Academy of Agricultural Sciences, SHANDONG PROV.

Feng Jiungo -- Hymenoptera: biotypes of *Trichogramma*.

Inner-Mongolian College of Agriculture & Animal Husbandry

Li Hong-Zhang (Lee, Hung-Chang) -- Coleoptera: Curculionidae.

Anhui (=Anhwei) Agricultural College, ANHUI PROV.

Prof. Ge, Zhong-Lin (Ge, Chung-Lin) -- Homoptera: Delphacidae.

Nanjing Agricultural College, JIANGSU PROV.

Ding, Jin-Hua -- Homoptera: Delphacidae (Acta Entomologica Sinica).

Dr. Huang, Jilin (Huang, Chi-Lin) -- Homoptera: Delphacidae. (deceased)

Mr. Tian, Li-Xin -- Homoptera: Delphacidae.

Table 1.--Taxonomic Specialists in the People's Republic of China (from directory of 151 specialists at 45 institutions)

Hymenoptera	27
Coleoptera	22
Acarina	21
Diptera	21
Homoptera	18
Lepidoptera	16
Siphonaptera	10
Hemiptera	8
Isoptera	6
Orthoptera	4
Apterygota	2
Protura	2
Anoplura	2
Thysanoptera	2
Neuroptera	2
Mecoptera	1
Collembola	1
Zoraptera	1
Ticks	1
	167

Table 2.--Numbers of new species/genera of insects and mites described in certain PRC journals

	Acta Entomologica Sinica	Acta Zootaxonomica Sinica	Shanghai Institute Entomology (Academia Sinica)	Zool. Res.
1954	28/2			
1955	11/0			
1956	10/0			
1957	42/8			
1958	22/0			
1959	22/2		10/0	
1960	3/0		3/0	
1961	42/1			
1962	30/0		3/0	
1963	105/12		2/0	
1964	110/9		9/1	
1965	25/1	72/4	35/1	
1966	4/1	5/0	---	
1967	---	---	---	
1968	---	---	---	
1969	---	---	---	
1970	---	---	---	
1971	---	---	---	
1972	---	---	---	
1973	18/2	---	---	
1974	67/6	---	3/1	
1975	19/4	---	2/1	
1976	77/7	---	3/0	
1977	90/5	---	6/2	
1978	64/6	---	2/0	
1979	72/7	56/8	8/1	
1980	52/5	129/8	---	15/0
1981	76/3	57/4	---	---
Total	989/81	319/24	86/7	15/0
Grand Total	1394/112			

Table 3.--PRC publications in systematic entomology by Order, 1954-1981

Diptera	86
Acarina	74
Coleoptera	47
Siphonaptera	47
Homoptera	42
Lepidoptera	37
Hemiptera	26
Hymenoptera	22
Orthoptera	18
Protura	18
Odonata	5
Anoplura	3
Neuroptera	3
Strepsiptera	2
Trichoptera	2
Zoraptera	2
Collembola	1
Ephemeroptera	1

"In the past 30 years, about 7,000 species of Chinese insects have been published, a total of 1,227 new species and subspecies, mostly in Acta Entomologica Sinica and Zootaxonomica Sinica. Twenty-six fascicles of the Economic Insect Fauna of China have been completed, covering 37 families and 3,313 species." (H. F. Chu, Acta Entomol. Sin. 22(3):240, 1979.)

Table 4.--Numbers of publications on systematics of insects and mites in China, by year

	Acta Entomologica Sinica	Acta Zootaxonomica Sinica	Shanghai Institute of Entomology (Academia Sinica)	Zool. Res.
1954	8			
1955	5			
1956	4			
1957	7			
1958	5			
1959	8		1	
1960	1		1	
1961	4		-	
1962	12		1	
1963	26		1	
1964	26		2	
1965	9	30	3	
1966	2	2	-	
1967	-	-	-	
1968	-	-	-	
1969	-	-	-	
1970	-	-	-	
1971	-	-	-	
1972	-	-	-	
1973	3	-	-	
1974	33	-	2	
1975	13	-	1	
1976	17	-	2	
1977	24	-	2	
1978	22	-	2	
1979	26	15	2	
1980	23	41	-	5
1981	28 + (#1-3)	24 +	-	-
Total	306 +	112 +	20	5

AFFILIATIONS OF U.S. SCIENTISTS

J. Roger Ables, Research Entomologist, Cotton Insects Research Laboratory, Agricultural Research Service, USDA, P.O. Drawer DG, College Station, Texas 77840.

Huai C. Chiang, Professor of Entomology, Department of Entomology, Fisheries, and Wildlife, University of Minnesota, St. Paul, Minnesota 55108.

Jack R. Coulson, Chief, Beneficial Insect Introduction Laboratory, Insect Identification and Beneficial Insect Introduction Institute (IIBIII), Agricultural Research Service, USDA, Beltsville, Maryland 20705.

R. James Cook, Plant Pathologist, Wheat Breeding and Production Research, Agricultural Research Service, USDA, Pullman, Washington 99163.

Robert D. Gordon, Location Leader, Systematic Entomology Laboratory, IIBIII, Agricultural Research Service, USDA, c/o National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560.

Kenneth S. Hagen, Professor of Entomology, Division of Biological Control, Department of Entomology, University of California, Berkeley, California 94720.

Richard L. Jones, Associate Professor, Department of Entomology, Fisheries, and Wildlife, University of Minnesota, St. Paul, Minnesota 55108.

Edgar L. King, Jr., Research Entomologist, Bioenvironmental Insect Control Laboratory, Agricultural Research Service, USDA, P.O. Box 225, Stoneville, Mississippi 38776.

Waldemar Klassen, National Research Program Leader for Pest Management, National Program Staff, Agricultural Research Service, USDA, Beltsville, Maryland 20705.

Lloyd Knutson, Chairman, IIBIII, Agricultural Research Service, USDA, Beltsville, Maryland 20705.

Alton N. Sparks, Research Entomologist, Southern Grain Insects Reseasrch Laboratory, Agricultural Research Service, USDA, Tifton, Georgia 31794.

William G. Yendol, Professor of Entomology, Pesticide Research and Graduate Study Laboratory, Department of Entomology, Pennsylvania State University, University Park, Pennsylvania 16802.

ON THE U.S. EXHIBIT IN CHINA ON ADVANCES IN CROP INSECT CONTROL

The spirit of cooperation between Chinese and American agricultural scientists reported herein was expressed dramatically and publicly with the opening of the exhibit, "U.S. Advances in Crop Insect Control" in Beijing in September 1981.

With both nations actively pursuing excellence in research and development of pest control programs, the exhibit was intended to provide Chinese professionals in entomology, plant protection and related agricultural sciences an overview of U.S. efforts.

Beyond its scientific value, however, the exhibit was in a way symbolic--being a special gift to the People's Republic of China, prepared by the U.S. International Communications Agency and presented by a consortium of U.S. agencies.

Opening ceremonies were televised nationally and reported in the Guangming Daily, the Beijing Science and Technology News, and other arteries of the Chinese media. The opening was attended by leaders of Chinese ministries, academies and institutes and by personnel of the U.S. Embassy. Many Chinese leaders who attended are individuals who also met with members of the three U.S. scientific delegations that made the fact-finding tours reported in this publication.

After the opening ceremonies, guests received guided tours of the exhibit's 1500 square feet of enlarged photographs, diagrams, instruments and devices, publications, and mounted insect specimens.

The first part of the exhibit consisted of five single-faced panels. They provided overviews of (1) U.S. production of three crops--corn, soybeans and cotton--which are important in both countries, (2) American research facilities in agriculture, (3) research on systematic entomology in the U.S. Department of Agriculture, (4) quarantine practices and facilities for clearing introduced natural enemies of crop pests, and (5) concepts and practicies of Integrated Pest Management.

A second part of the exhibit consisted of a series of free-standing cubes which presented specific control strategies: (1) predators and parasites, (2) microbial and viral insecticides, (3) functional modification, (4) behavioral modification, and (5) host resistance to insects.

Sophisticated and technical, the exhibit was primarily of interest to Chinese plant protection specialists and administrators. However, after special showings for 200-member groups from scientific institutions, the exhibit was opened, by invitation, to professional workers from throughout the People's Republic of China.

Because the exhibit brought forth the very latest of U.S. pest control efforts (rather than a rehash of textbook concepts), the Chinese maximized its impact on their plant protection sciences by training four people as narrators, by translating the information into Chinese and by adding the translation to the exhibit. Translations were also bound in booklets for visitors. And face-by-face photographic slides were taken, combined with information booklets, and sent to agricultural institutes and experiment stations in the Chinese provinces.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] pamphlets, charts and [illegible] comprised [illegible]. [illegible] were used [illegible] [illegible] material for [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] at [illegible] [illegible].

[illegible] consisted [illegible] of colored photographs, diagrams, instruments and [illegible], [illegible], and [illegible] [illegible].

The first part of the exhibit consisted of [illegible] [illegible] [illegible] [illegible] (1) a [illegible] of [illegible] [illegible], [illegible] and [illegible] [illegible] [illegible] [illegible]. (2) [illegible] [illegible] [illegible] [illegible] (3) [illegible] [illegible] [illegible] [illegible] of agriculture, (4) [illegible] [illegible] [illegible] [illegible] natural enemies of crop pests, and (5) [illegible] and [illegible] [illegible] [illegible].

A second part of the exhibit consisted of a series of [illegible] [illegible] which presented [illegible] control [illegible]: (1) [illegible] [illegible] [illegible] (2) [illegible] [illegible] [illegible], [illegible] [illegible] [illegible] [illegible], (5) [illegible] [illegible], and (5) [illegible] [illegible] on insects.

[illegible] [illegible] [illegible] plant protection specialists and administrators [illegible] special meetings for [illegible] groups were [illegible] [illegible]. The exhibit was opened, by invitation, to professional workers from throughout the [illegible] Republic of China.

Because the exhibit brought forth the very latest of [illegible] and [illegible] [illegible] than a [illegible] of [illegible] [illegible], the [illegible] [illegible] the [illegible] of [illegible] production workers by [illegible] [illegible] [illegible] translating the information into Chinese and by making the [illegible] of the exhibit. Translations were also [illegible] [illegible] for the [illegible]. [illegible] photographic slides were taken, combined with information, [illegible] [illegible] agricultural institutions and [illegible] [illegible] in the [illegible] provinces.